



**DRAFT FINAL
FEASIBILITY STUDY
INSTALLATION RESTORATION PROGRAM
SITES 2, 3, 5 AND 6**



**NEW JERSEY AIR NATIONAL GUARD
177th FIGHTER WING
140 LANGLEY ROAD
EGG HARBOR TOWNSHIP, NEW JERSEY**

prepared for:

**Air National Guard Headquarters
Joint Base Andrews, Maryland**

November 22, 2011

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LIST OF ACRONYMS/ABBREVIATIONS

ABB	ABB Environmental Services, Inc.
AC	Atlantic City
ACIA	Atlantic City International Airport
ANG	Air National Guard
ARAR	Applicable or Relevant and Appropriate Requirements
AS/SVE	Air Sparge/Soil Vapor Extraction
AWQC	Ambient Water Quality Criteria
BaP	Benzo(a)pyrene
bgs	Below Ground Surface
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfm	cubic feet per meter
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	Constituent of Concern
CVOC	Chlorinated Volatile Organic Compound
CY	Cubic Yards
DbA	Dibenzo(a,h)anthracene
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DRO	Diesel-Range Organics
ERH	Electrical Resistance Heating
ERP	Environmental Restoration Program
ESSI	Expanded Supplemental Site Investigation
FAA	Federal Aviation Administration
FS	Feasibility Study
ft	Feet
ft ²	Square feet
FW	Fighter Wing
GAC	Granular Activated Carbon
gpm	gallons per minute
GRA	General Response Action
GWQS	Ground Water Quality Standards
HHRA	Human Health Risk Assessment
i	Groundwater flow gradient
IC	Institutional Control
IGW	Impact to Groundwater
IRP	Installation Restoration Program

ISCO	In-Situ Chemical Oxidation
K	Hydraulic conductivity
LNAPL	Light Non-Aqueous Phase Liquid
LSRP	Licensed Site Remediation Professional
MCL	Maximum Contaminant Level
mg/kg	Milligrams per Kilogram
mg/l	Milligrams per Liter
MNA	Monitored Natural Attenuation
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emissions Standards for Hazardous Air Pollution
NFA	No Further Action
NJAC	New Jersey Administrative Code
NJANG	New Jersey Air National Guard
NJDEP	New Jersey Department of Environmental Protection
NPDES	National Pollution Discharge Elimination System
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Act
PA	Preliminary Assessment
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethene
PP	Proposed Plan
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit
PRB	Permeable Reactive Barrier
RAO	Remedial Action Objective
RAP	Remedial Action Permit
RCRA	Resource Conservation and Recovery Act
RDC	Residential Direct Contact
RI	Remedial Investigation
ROD	Record of Decision
ROI	Radius of Influence
ROM	Rough Order of Magnitude
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SCITEK	Science & Technology, Inc.
SDWA	Safe Drinking Water Act
SI	Site Investigation

SRS	Soil Remediation Standards
SSI	Supplemental Site Investigation
SVOC	Semi-Volatile Organic Compound
TCE	Trichloroethene
TOC	Total Organic Carbon
TRC	TRC Environmental Corporation
µg/l	Micrograms per liter
USEPA	United States Environmental Protection Agency
USC	United States Code
UST	Underground Storage Tank
VOC	Volatile Organic Compound

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EXECUTIVE SUMMARY

This Feasibility Study (FS) has been prepared to present the remedial alternatives evaluation for Installation Restoration Program (IRP) Sites 3 and 6 at the 177th Fighter Wing of the New Jersey Air National Guard (NJANG) located in Egg Harbor Township, New Jersey. In addition, the FS will support the request for no further action (NFA) status for IRP Sites 2 and document the transfer of IRP Site 5 from the United States Environmental Protection Agency (USEPA) to the New Jersey Department of Environmental Protection (NJDEP).

E.1 PURPOSE

The purpose of this FS is to evaluate an appropriate range of remedial alternatives, including No Action, which will reduce risks to human health and the environment at each Site, based on data, analyses, and other information generated during the Remedial Investigation/Feasibility Study process. This document presents site descriptions and histories for IRP Site 3 and IRP Site 6, as well as fate and transport of contaminants, nature and extent of contamination, identification and screening of remedial technologies and process options, development and screening of alternatives, detailed analysis of alternatives, and a comparative analysis of alternatives for both sites. For IRP Site 2, this FS will document that USEPA has requested one additional groundwater monitoring event to confirm a downward trend in contaminant concentrations. For IRP Site 5, this FS will document the transfer of this Site from the USEPA to the NJDEP.

E.2 IRP Site 2

IRP Site 2 consists of two grass-covered areas located on either side of an existing concrete flight apron, where historical de-fueling activities occurred. The Site is delineated by the FAA property line to the north, by Taxiway H to the east, by the apron edge to the south, and by the apron's edge to the west. Historically, IRP Site 2 was subdivided into two subparts, Subpart A and B since they were identified points of defueling.

Previous investigations demonstrated that with the exception of the thin layer of light non-aqueous phase liquid (LNAPL) observed in piezometer 2PZ4, there were no other groundwater impacts. Although a background study was not conducted during the 2010 remedial investigation (RI), several soil analytical results for ethylbenzene, naphthalene, and 1,2,4-trimethylbenzene were above the United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for residential soil. However, there were no corresponding impacts to groundwater. As requested by the USEPA (via email correspondence dated January 2011), it is proposed that one additional groundwater sample be collected from piezometer 2PZ4 for laboratory analysis of diesel-range organics (DRO) to confirm that concentrations in groundwater are continuing to decrease. If the results do confirm the downward trend, then NFA status will be requested. If a downward trend is not confirmed, additional monitoring will be recommended.

E.3 IRP Site 3

IRP Site 3 consists of a former wash rack located along the northern portion of Earhart Drive between Buildings 40 and former Building 36, just to the south of current Building 249. Historical wash rack operations included the storage of waste oils and the potential use of chlorinated compound based cleaners/solvents. The results of previous investigations indicate that former wash rack activities resulted in the discharge of chlorinated volatile organic compounds and waste oil to the surrounding groundwater at concentrations exceeding NJDEP Ground Water Quality Standards (GWQS). A background study was not conducted for IRP Site 3.

The organic dissolved phase constituents detected at concentrations exceeding the NJDEP GWQS and identified in the Human Health Risk Assessment (HHRA) as IRP Site 3 constituents of concern (COCs) included tetrachloroethene (PCE), chloroform and naphthalene. The observed shallow groundwater plume geometry based on these COCs generally extends from approximately 18 to 60 feet (ft) below ground surface and extends approximately 550 ft horizontally from the former wash rack area towards the southeast. Within the deeper portion of the shallow aquifer, chloroform was observed at concentrations exceeding the GWQS. Site groundwater data suggest the maximum PCE concentration of 59 micrograms per liter ($\mu\text{g/l}$) is present at the site. Since chloroform and naphthalene are reported to be within 2 $\mu\text{g/L}$ of the proposed cleanup criteria (1 and 2 $\mu\text{g/l}$ respectively), it is anticipated that PCE will be the primary driver regarding cleanup activities.

The proposed cleanup criteria for IRP Site 3 were derived from the NJDEP GWQS and include the following:

Constituent	Media	Clean-Up Criteria
IRP Site 3		
PCE	Groundwater	1 $\mu\text{g/l}$
Chloroform	Groundwater	1 $\mu\text{g/l}$
Naphthalene	Groundwater	2 $\mu\text{g/l}$

The remedial alternative objectives (RAOs) identified for IRP Site 3 are as follows:

- Reduce the contaminant levels in groundwater to below the applicable GWQS;
- Prevent exposure to contaminated groundwater that could be harmful to human health and the environment;
- Prevent further migration of contaminated groundwater; and,
- Achieve site closure in approximately 30 years by actively treating PCE areas greater than 20 $\mu\text{g/l}$.

General response actions (GRAs) screened with respect to technical implementability to satisfy the RAOs are:

- No Action;
- Institutional Controls;
- Containment;
- In-Situ Technologies; and,
- Ex-Situ Technologies and Discharge.

The most viable remedial process options for groundwater at IRP Site 3 are identified as No Action, monitored natural attenuation (MNA), air sparging/soil vapor extraction (AS/SVE), in-situ chemical oxidation (ISCO), and permeable reactive barrier (PRB). These were developed into preliminary alternatives for screening purposes. Each preliminary alternative was screened for applicability at the site and either retained or not retained for further evaluation with regard to effectiveness, implementability, and cost.

As a result of this screening process, the *alternatives* carried forward for detailed analysis were:

- Alternative 1: No Action;
- Alternative 2: MNA;
- Alternative 3: AS/SVE and MNA; and,
- Alternative 4: ISCO and MNA.

After comparatively evaluating the four retained alternatives against evaluation criteria as outlined by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Alternative 1 (No Action) and Alternative 2 (MNA) are not suitable options because they will not satisfy the RAOs of preventing further migration of contaminated groundwater and achieving site closure in approximately 30 years by actively treating PCE areas greater than 20 µg/l.

Both Alternative 3 (AS/SVE and MNA) and Alternative 4 (ISCO and MNA) do satisfy all the RAOs. Alternatives 3 and 4 both consist of active remediation of the source areas, which will prevent plume migration and allow for site closure within 30 years. The primary difference between Alternatives 3 and 4 is that Alternative 3 will require continued operation and maintenance of the AS/SVE systems, will require a significant amount of energy to operate the AS/SVE systems, and will create a secondary waste stream. In addition, Alternative 3 has uncertainties associated with the implementability of the remedy primarily because it will require more than 2,300 feet of piping to be trenched. If utilities or underground obstacles are encountered, it could significantly delay the construction of the AS/SVE systems. Alternative 4 does not require a system, consume large amount of energy, or produce a secondary waste stream and is easily implemented. Alternative 4 also reduces toxicity, mobility, or volume through treatment because it will both reduce the concentration and mass of PCE through treatment, and prevent the migration of the PCE plume. Therefore, Alternative 4 is the preferred remedial alternative for PCE-impacted groundwater at IRP Site 3.

E.3 IRP SITE 5

IRP Site 5, known as the Liquid Waste Storage Area, is located behind Building 65 where petroleum and other liquids were historically stored. The Site is located adjacent to the intersection of Bleriot Court and Byrd Highway behind the NJANG Vehicle Maintenance Compound. The site consists of an approximate 90-foot by 155-foot rectangular area. A fence enclosing the maintenance compound forms the site's northern and eastern borders. The area immediately west of the Site is paved with asphalt and used for parking. The area to the south of the Site has a gravel base and has been historically used as an equipment staging area.

IRP Site 5 has been in operation since 1958. Records search and interviews conducted during the Preliminary Assessment disclosed that disabled vehicles, including fuel tank trucks, were parked on the unpaved surface area of IRP Site 5. A concrete containment pad is identified in the southern part of the Site and used to stage JP-4, waste oils, and solvents.

As recommended in the RI Report and subsequently approved by both USEPA and NJDEP, the regulatory oversight of IRP Site 5 has been transferred to the NJDEP, and the Site will be managed under the New Jersey Licensed Site Remediation Professional (LSRP) program. The justification for transferring the regulatory oversight of IRP Site 5 to the NJDEP is that the only remaining environmental COCs at the Site are dissolved volatile organic compounds (VOCs) associated with a former underground storage tank, which can be most efficiently managed under the New Jersey Underground Storage Tank Rules (N.J.A.C. 7:14B) and the LSRP Program.

E.4 IRP SITE 6

IRP Site 6 is located outside of the NJANG Alert Area near the intersection of Runways 13-31 and 4-22, east of the abandoned blast pad. The blast pad served as a jet engine test site for several years, however, the dates of operation are not known but thought to have ceased in the early 1980s. During the RI, site soils were investigated to determine potential impacts based on historical use. The soil analytical data were compared to the New Jersey Residential Direct Contact (RDC) Soil Remediation Standards (SRS). Constituent concentrations detected in soil exceeding the NJRDCSRS included organic and inorganic constituents. The organic contaminants detected at concentrations exceeding the NJRDCSRS in soil and identified in the HHRA as COCs for IRP Site 6 include benzo(a)pyrene and dibenz(a,h)anthracene. Lead was detected in all soil samples collected at IRP Site 6, however, all concentrations were below the NJRDCSRS. Three samples exhibited lead concentrations above the NJDEP SRS Impact to Ground Water Soil Screening Level of 59 milligrams per kilogram (mg/kg). Background soil concentrations for metals and PAHs have not been developed for IRP Site 6.

The proposed cleanup criteria for IRP Site 6 were derived from the NJDEP SRS and include the following:

Constituent	Media	Clean-Up Criteria
IRP Site 6		
Benzo(a)pyrene	Soil	0.2 mg/kg
Dibenz(a,h)anthracene	Soil	0.2 mg/kg
Lead	Soil	59 mg/kg

The RAOs identified for IRP Site 6 are as follows:

- Reduce the contaminant levels in soil to the NJDEP soil standards by removing impacted soil from the site;
- Prevent exposure to contaminated soil that could be harmful to human health and the environment; and,
- Prevent migration of contaminants from soil leaching to groundwater.

The GRAs identified for IRP Site 6 are as follows:

- No Action;
- Institutional Controls; and,
- Ex-Situ Technologies and Disposal.

The total amount of contaminated soil at IRP Site 6 is 29 cubic yards (CY). Due to the small size of the area requiring remediation, a presumptive remedy was proposed for IRP Site 6. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and scientific and engineering evaluation of performance data on technology implementation. Since a presumptive remedy is a technology that generally will be the most appropriate remedy for a specified type of site, the presumptive remedy approach will accelerate site-specific analysis of remedies by focusing the FS efforts. Therefore, the process of remedial technology and process option identification and evaluation were not performed and only the presumptive remedy and no action were carried forward for development into alternatives.

In accordance with the NJDEP Site Remediation Program, discrete area discharges (300 CY or less of contaminated soil) are areas of contamination that can readily be remediated by excavation and off-site disposal using routinely available construction equipment and conventional techniques.

Therefore, the following alternatives were developed for IRP Site 6:

- Alternative 1: No Action; and,
- Alternative 2: Excavation and Disposal.

After comparatively evaluating the two retained alternatives against evaluation criteria as

outlined by the NCP, Alternative 1 (No Action) is not a viable alternative because it does not meet the threshold criteria of protecting human health and the environment or complying with applicable or relevant and appropriate requirements (ARARs).

Alternative 2, Excavation and Disposal, does meet the threshold criteria because it would be protective of human health and the environment by reducing concentrations of impacted soil at IRP Site 6 to below the cleanup criteria (chemical-specific ARARs). Excavation and Disposal is easily implementable as well as technically and administratively feasible.

E.5 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were developed based on the findings presented in this FS and the 2011 RI Report (ANG, 2011).

- One groundwater monitoring event will be conducted at IRP Site 2 from piezometer 2PZ4 for laboratory analysis of DRO to confirm that concentrations in groundwater are continuing to decrease. If the results confirm the downward trend, then NFA status will be requested. If a downward trend is not confirmed, additional monitoring will be recommended.
- Alternative 4, ISCO and MNA, is the preferred alternative for remediating the PCE-impacted groundwater at IRP Site 3. This alternative will meet the RAOs of preventing further migration of contaminated groundwater and achieving site closure in approximately 30 years by actively treating PCE areas greater than 20 µg/l. This remedial alternative also protects human health and the environment, complies with ARARs, reduces toxicity, mobility, or volume through treatment and is the most cost effective alternative evaluated.
- Because the only remaining COCs at IRP Site 5 are VOCs associated with a former underground storage tank, regulatory oversight of IRP Site 5 has been transferred to the NJDEP and will be managed under the New Jersey Underground Storage Tank Rules and LSRP program.
- Alternative 2, Excavation and Disposal, is the preferred alternative for IRP Site 6 because it meets the RAOs and is protective of human health and the environment by reducing concentrations of impacted soil to below the cleanup criteria. This alternative is readily implementable as well as technically and administratively feasible. This remedial alternative complies with ARARs, is effective in both the short-term and long-term, and is cost effective.

1.0 INTRODUCTION

This Feasibility Study (FS) has been prepared to present the remedial alternatives evaluation for Installation Restoration Program (IRP) Sites 3 and 6 at the 177th Fighter Wing (FW) of the New Jersey Air National Guard (NJANG) located in Egg Harbor Township, New Jersey ("Site") (**Figure 1-1**). For IRP Site 2, this FS will document that United States Environmental Protection Agency (USEPA) has requested one additional groundwater monitoring event to confirm a downward trend in contaminant concentrations. For IRP Site 5, this FS will document the transfer of this Site from the USEPA to the New Jersey Department of Environmental Protection (NJDEP).

The FS was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), NJDEP environmental cleanup statutes and rules, and the Air National Guard (ANG) Environmental Restoration Program (ERP) Investigation Guidance (ANG, 2009).

1.1 PURPOSE AND ORGANIZATION OF THE REPORT

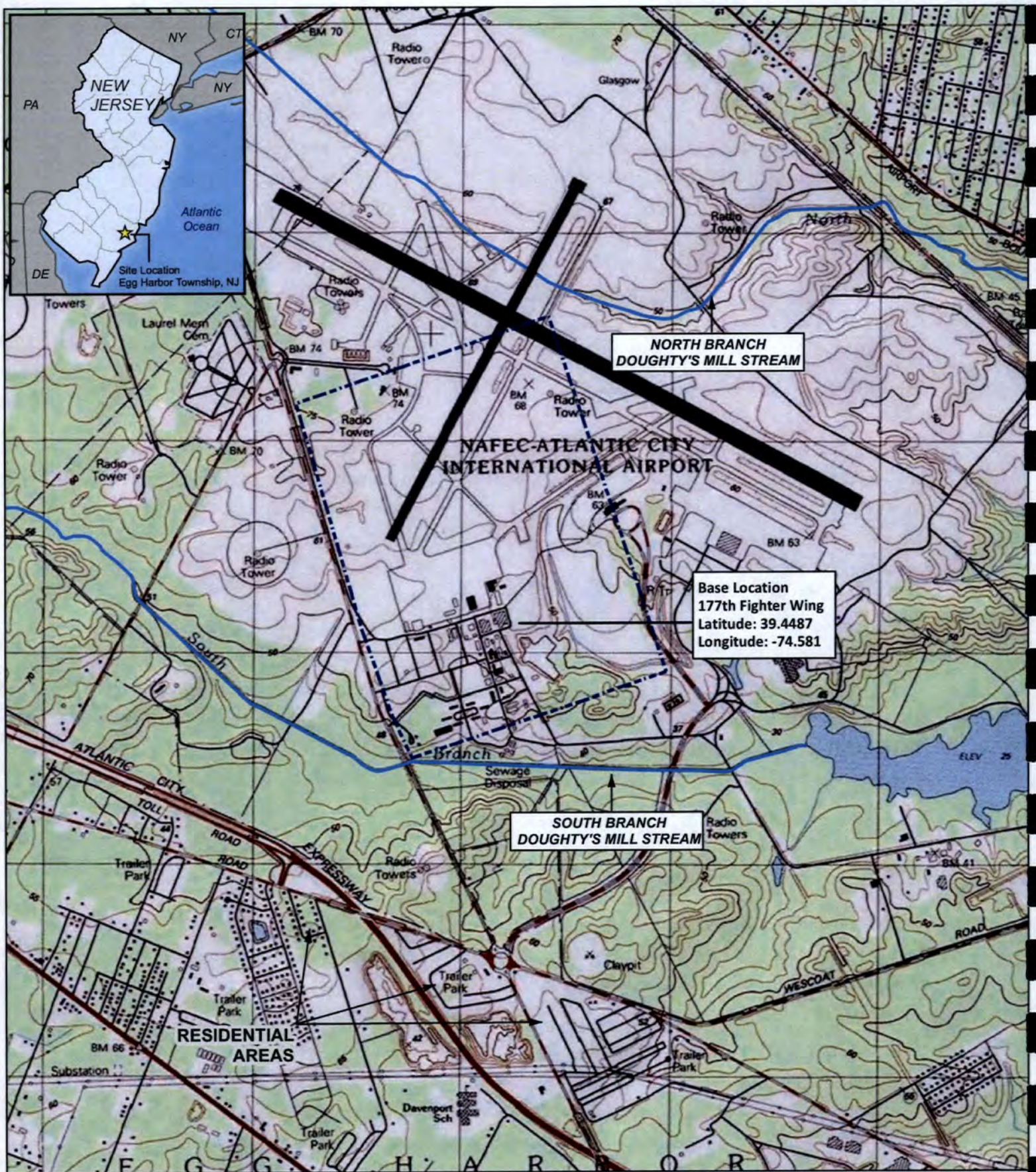
1.1.1 Purpose

The purpose of this FS is to evaluate an appropriate range of remedial alternatives, including No Action, that will reduce risks to human health and the environment at Sites 3 and 6, based on data, analyses, and other information generated during the Remedial Investigation/Feasibility Study (RI/FS) process. For IRP Site 2, this FS will document that USEPA has requested one additional groundwater monitoring event to confirm a downward trend in contaminant concentrations. For IRP Site 5, this FS will document the transfer of this Site from the USEPA to the NJDEP.

1.1.2 Organization of the Report

The components of this FS Report are identified in CERCLA regulations (40 Code of Federal Regulations [CFR] § 300.430), the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988), and the ANG ERP Investigation Guidance (ANG, 2009) and include:

- Section 1.0 (Introduction) provides introductory and background material, summarizes the nature and extent of contamination at IRP Sites 3 and 6, information related to contaminant fate, transport, and bioaccumulation of the constituents of concern (COCs) identified, and risks to human health and the environment posed by the COCs. This section also presents information regarding the status of IRP Sites 2 and 5.

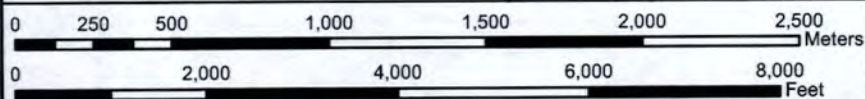


**New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, NJ**



**FIGURE 1-1
Base Location Map**

Feasibility Study Report
New Jersey Air National Guard - 177th Fighter Wing
Egg Harbor Township, New Jersey



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- Section 2.0 (Identification and Screening of Technologies) details the four steps through which remedial technologies are identified and screened. The first step is establishing the remedial action objectives (RAOs) which specify COCs and media of concern and associated remediation goals. The second step is establishing medium-specific general response actions (GRAs), such as treatment, containment, institutional action, etc., to satisfy the RAOs. In the third step, potentially applicable remedial technologies and associated process options (specific processes within each technology type) are listed and evaluated for technical implementability. This step reduces the universe of potentially applicable technology types and process options to only those which may be effectively implemented at each site. The final step in Section 2 is the evaluation of process options based on relative effectiveness, technical and administrative implementability, and relative cost. The final outcome of Section 2 is a list of process options, which either on their own or in combination may achieve the established RAOs.
- Section 3.0 (Development and Screening of Alternatives) utilizes the process options developed in Section 2 and assembles them to form a range of site-wide alternatives to meet the established RAOs. These alternatives are evaluated to ensure they are effective (i.e. protective of human health and the environment), implementable at the site, and cost effective based on rough order of magnitude (ROM) costs. The results of this evaluation will determine which preliminary alternatives will be retained for detailed analysis.
- Section 4.0 (Detailed Analysis of Alternatives) presents detailed descriptions and individual analyses of features unique to each alternative according to each of the nine FS required evaluation criteria. A comparative analysis is then presented to evaluate the relative performance of each alternative in relation to each specific evaluation criterion.
- Section 5.0 (Conclusions and Recommendations) presents and recommends a preferred remedial alternative for each site.

1.2 BACKGROUND INFORMATION

The NJANG, 177th FW, is located at approximately west longitude 74°35'00" by north latitude 39°27'00" in Egg Harbor Township, Atlantic County, New Jersey (**Figure 1-1**). The Base is located in the southwestern portion of the Atlantic City (AC) International Airport (ACIA) and the NJANG has been active at the facility since 1958, occupying two tracts of land, totaling 280 acres. These tracts, located to the northwest and west of the Federal Aviation Administration (FAA) terminal, are owned by the FAA. In addition, the Base is located within the Pinelands National Reserve, an ecologically sensitive and protected area of New Jersey.

The Base currently exists as primarily improved areas with buildings, roadways, aircraft parking aprons and other structural improvements. The Base is surrounded by the ACIA to the north east and west and green space and the AC Expressway to the south.

1.3 SITE DESCRIPTION

1.3.1 IRP Site 2

IRP Site 2 consists of two grass-covered areas located on either side of an existing concrete flight apron, where historical de-fueling activities occurred (**Figure 1-2**). The site consists of an approximate 1,450-foot by 125-foot irregular area immediately adjacent to the northern perimeter of the existing concrete flight apron. The size of the area is a function of the possibility that defueling activities may have been conducted at various points along the apron. The Site is delineated by the FAA property line to the north, Taxiway H to the east, the apron's edge to the south and west. Historically, IRP Site 2 was subdivided into two subparts, Subpart A and B since they were identified points of defueling (**Figure 1-3**).

1.3.2 IRP Site 3

IRP Site 3 consists of a former wash rack located along the northern portion of Earhart Drive between Buildings 40 and former Building 36, just south of current Building 249 (**Figure 1-4**). The former wash rack area is concrete covered and slopes toward Earhart Drive with two catch basins located in the down gradient corners of the pad. The Site Investigation (SI) (ABB Environmental Services, Inc. [ABB], 1995) reported that the catch basins were connected to the Base stormwater drainage system.

1.3.3 IRP Site 5


IRP Site 5, known as the Liquid Waste Storage Area, is located behind Building 65 where petroleum and other liquids were historically stored (**Figure 1-5**). The Site is located adjacent to the intersection of Bleriot Court and Byrd Highway behind the NJANG Vehicle Maintenance Compound. The site consists of an approximate 90-foot by 155-foot rectangular area. A fence enclosing the maintenance compound forms the site's northern and eastern borders. The area immediately west of the Site is paved with asphalt and used for parking. The area to the south of the Site has a gravel base and has been historically used as an equipment staging area.

1.3.4 IRP Site 6

IRP Site 6 is located outside of the NJANG Alert Area near the intersection of Runways 13-31 and 4-22 (**Figure 1-6**). The Site, which is approximately 11,700 square feet (ft²), is located to the east of the abandoned blast pad. The blast pad served as a jet engine test site for several years; however, the actual dates of operation are not known but thought to have ceased in the early 1980s (ABB, 1995). The area adjacent to the former test pad is currently grass covered.



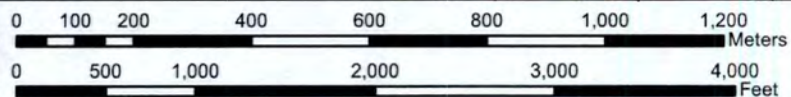
SYMBOL KEY

 IRP Site Boundary

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FIGURE 1-2
Location of IRP Sites 2, 3, 5, and 6
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SYMBOL KEY

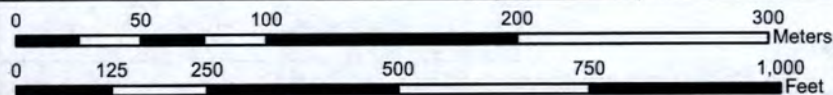
- 400 Building Number
- Site 2
- Subpart A
- Subpart B

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FIGURE 1-3 IRP Site 2 Location Map

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SYMBOL KEY

400 Building Number

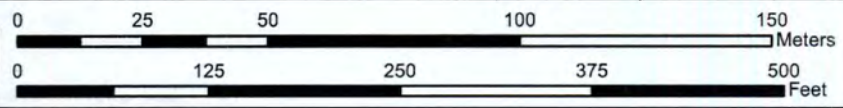
Site 3

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FIGURE 1-4
IRP Site 3 Location Map

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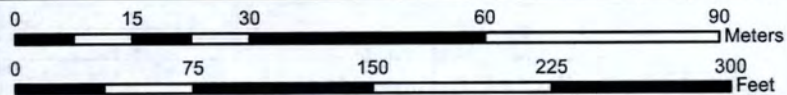


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**FIGURE 1-5
IRP Site 5 Location Map**

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SYMBOL KEY

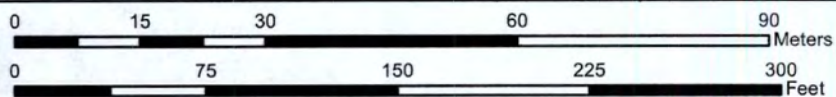


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**FIGURE 1-6
IRP Site 6 Location Map**

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1.4 SITE HISTORY

1.4.1 IRP Site 2

According to the Preliminary Assessment (PA), IRP Site 2 was used as a defueling area from 1965 to 1975. During this period, aircraft were routinely defueled into tank trucks or bowzers. Historical information indicated that fuel that could not be pumped from the aircraft into these receptacles was regularly discharged to the grassy area adjacent to the flight apron (TRC Environmental Corp. [TRC], 2003).

Previous environmental investigations conducted at IRP Site 2 include:

- Preliminary Assessment, (Science & Technology, Inc. [SCITEK], 1989);
- Site Investigation (ABB, 1995);
- Supplemental Site Investigation (SSI) (Smith Environmental Technologies, Corp. [Smith], 1996); and,
- Quarterly Groundwater Sampling Reports (TRC, 2002a, 2002b, 2002c, 2002d).

To determine the presence or absence of contamination in groundwater and surface and subsurface soil, the SI field work was conducted in two phases as detailed below.

Phase I

- 86-point soil gas survey
- Installation of four piezometers (including 2PZ4) to assess the groundwater flow direction.

Phase II

- Sampling and analysis of eight surface soil samples
- Installation of two monitoring wells
- Collection of two rounds of groundwater samples
- Included piezometer 2PZ4 in the second round of sampling after a thin layer of light non-aqueous phase liquid (LNAPL) was observed during routine water-level monitoring.

The conclusions of the SI for IRP Site 2 indicated potential contamination in soil and groundwater, which warranted further investigation. A background study was not conducted during the investigation.

To further investigate the area immediately adjacent to 2PZ4, an SSI was conducted. The investigation included the installation of soil-vapor survey points and collection of one surface soil sample and three subsurface soil samples. In addition, two monitoring wells (2MW201 and 2MW202) were installed and sampled in conjunction with the existing monitoring well and piezometer 2PZ4. SSI analytical results indicated that no volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, or polychlorinated biphenyls (PCBs) were present in groundwater at concentrations exceeding the NJDEP ground water quality

standards (GWQS). With the exception of the thin layer of LNAPL observed in piezometer 2PZ4, no other groundwater impacts were observed.

During the RI (ANG, 2011), several soil analytical results for ethylbenzene, naphthalene, and 1,2,4-trimethylbenzene were above the USEPA Regional Screening Levels (RSLs) for residential soil. However, compliance averages were below the NJDEP Residential Direct Contact (RDC) Soil Remediation Standards (SRS), with the exception of xylenes. According to the data presented in the RI Report, the following constituents were reported above the NJDEP Impact to Groundwater (IGW) Screening Criteria:

- Ethylbenzene and xylenes were above the criteria in one soil sample; and
- Methylene chloride was above the criteria in two soil samples.

Although low level concentrations of ethylbenzene, xylenes and methylene chloride were present in soil, no corresponding impacts to groundwater were observed. It should be noted that 1,2,4-trimethylbenzene was detected in one groundwater sample collected from piezometer 2PZ4; however, there is not an established NJDEP GWQS cleanup criteria for that constituent.

As presented in the RI Report (ANG, 2011), the LNAPL layer previously observed in piezometer 2PZ4 was not observed during the three most recent sampling events conducted to reflect seasonal groundwater conditions. A background study was not conducted during the investigation. However, no groundwater constituents analyzed were above the NJDEP Practical Quantitation Limits (PQLs) during the six most recent sampling events at IRP Site 2. This includes diesel-range organics (DRO) historically present in piezometer 2PZ4 which was below the 500 micrograms per liter ($\mu\text{g/l}$) Interim Generic Ground Water Quality Criterion for total synthetic organic compounds established by the NJDEP (under New Jersey Administrative Code [N.J.A.C.] 7:9C - Appendix Table 2).

As noted in the RI Report (ANG, 2011), the residual contaminant concentrations present in groundwater at IRP Site 2 are below the NJDEP GWQS and do not pose an unacceptable risk to human health. In addition, residual contaminant concentrations in groundwater at IRP Site 2 do not pose an ecological risk because the groundwater discharge to surface water pathway is not complete.

As requested by the USEPA (via email correspondence dated January 2011, **Appendix A**), it is proposed that one groundwater sample be collected from piezometer 2PZ4 for laboratory analysis of diesel-range organics (DRO) to confirm that concentrations in groundwater are continuing to decrease. If the results do confirm the downward trend, then a request for NFA will be requested. If a downward trend is not confirmed, additional monitoring will be recommended. Because no remedial actions are currently warranted at IRP Site 2, this site is not further discussed in this FS.

1.4.2 IRP Site 3

The former wash rack associated with IRP Site 3 was reportedly used from approximately 1942

until 1974 as the primary location of aircraft cleaning for the Naval Air Station (1942 to 1958) and the NJANG (1958 to 1974) (ABB, 1995). Historical wash rack operations included the storage of waste oils and the potential use of chlorinated compound-based cleaners/solvents.

Previous environmental investigations conducted at IRP Site 3 include:

- Site Investigation (ABB, 1995);
- Supplemental Site Investigation (Smith, 1996);
- Expanded Supplemental Site Investigation (ESSI) (TRC, 2003); and,
- Remedial Investigation (ANG, 2011).

The results of previous investigations indicate that former wash rack activities have resulted in the discharge of chlorinated volatile organic compounds (CVOCs) and waste oil to the surrounding groundwater at concentrations exceeding NJDEP GWQS. A background study was not conducted for this site.

1.4.3 IRP Site 5

IRP Site 5 has been in operation since 1958. Records search and interviews conducted during the PA disclosed that disabled vehicles, including fuel tank trucks, were parked on the unpaved surface area of IRP Site 5. A concrete containment pad is identified in the southern part of the Site and used to stage JP-4, waste oils, and solvents.

As recommended in the RI Report and subsequently approved in the June 9, 2011 USEPA approval letter (with NJDEP concurrence stated in a June 9, 2011 email, **Appendix A**), the regulatory oversight of IRP Site 5 has been transferred to the NJDEP, and the Site will be managed under the New Jersey Licensed Site Remediation Professional (LSRP) program. The justification for transferring the regulatory oversight of IRP Site 5 from the USEPA to the NJDEP is that the only remaining COCs at the Site are dissolved VOCs associated with a former underground storage tank (UST), which can be most efficiently managed under the New Jersey Underground Storage Tank Rules (N.J.A.C. 7:14B) and the LSRP Program. As such, an evaluation of potential remedial alternatives for IRP Site 5 was not performed as part of this FS.

1.4.4 IRP Site 6

The former blast pad was used as a jet engine test cell where engine turbines are tested during maintenance and repair activities. Typically jet engine test cell operations generate jet fuel wastes and waste oil. Specific waste handling activities at IRP Site 6 were not reported during previous investigations, which include:

- Preliminary Assessment (SCITEK, 1989);
- Site Investigation (ABB, 1995);
- Supplemental Site Investigation (Smith, 1996);
- Expanded Supplemental Site Investigation (TRC, 2003); and,
- Remedial Investigation (ANG, 2011).

The results of the 2011 RI and other previous investigations indicate that shallow soils (0 - 6 inches below ground surface [bgs]) at IRP Site 6 are impacted by lead and SVOCs at concentrations above the NJDEP SRS.

1.5 GEOLOGY

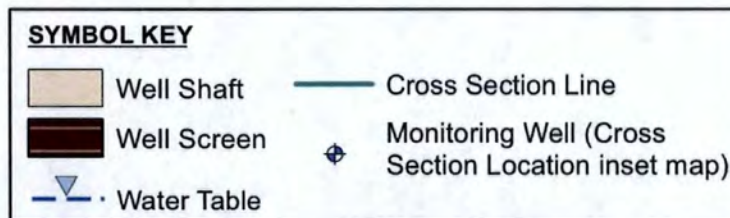
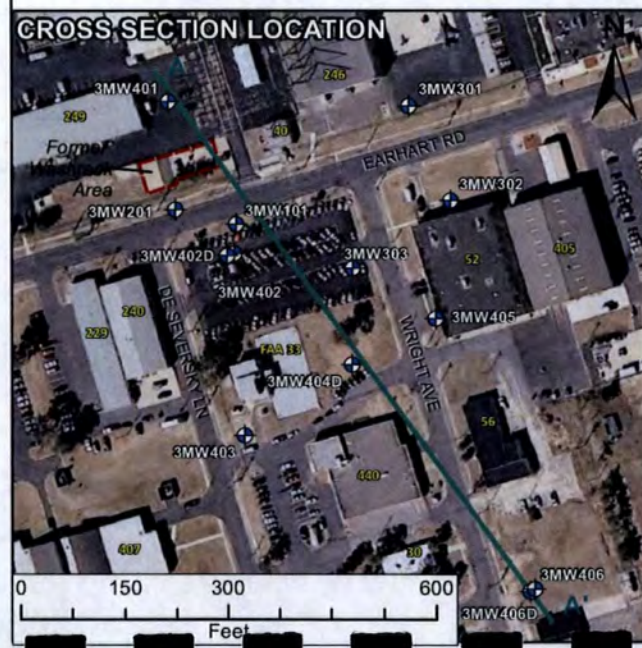
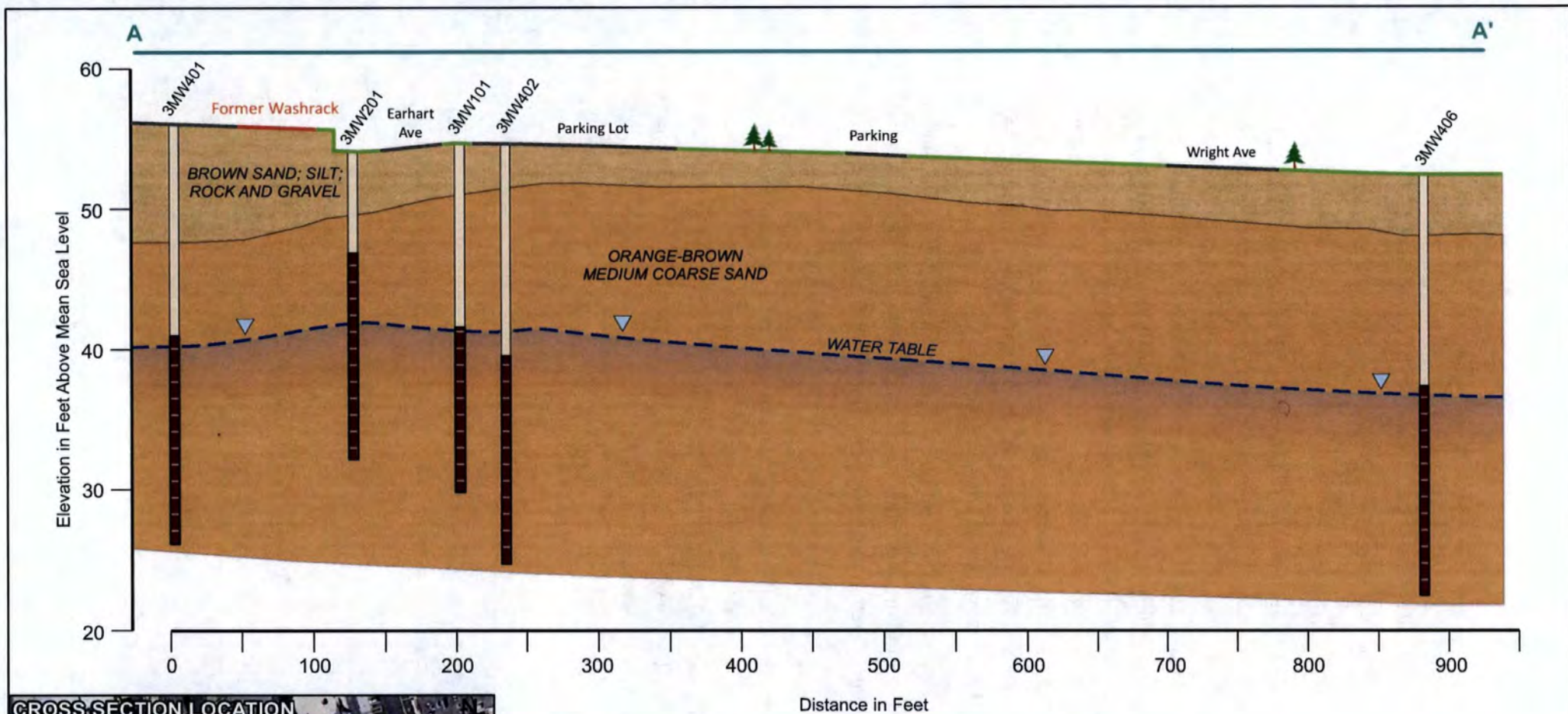
The geology of the Atlantic Coastal Plain consists of an eastward thickening apron of unconsolidated and partly consolidated sediments (Cretaceous-Tertiary) which extends along the east coast. These sediments overlap the Precambrian to Paleozoic crystalline basement complex and gently dip towards the southeast (ABB, 1995). In the vicinity of NJANG, the sedimentary wedge is estimated to be approximately 4,000 feet (ft) thick, but thickens towards the east in the direction of the regional dip (Richards, et al., 1962). The geology of Atlantic County includes the Precambrian and Paleozoic basement rocks which, in this area, are assumed to be very flat in relief, sloping southeastward toward the ocean. Overlying this are the Cenozoic and Mesozoic deposits. The three geologic units identified for the site are the Miocene Kirkwood Formation, the Miocene Cohansey sand, and the Quaternary Bridgeton Formation.

Soils encountered during previous investigations include fine- to coarse-grained sand, silty sands and clayey sands at IRP Site 3 and fine- to coarse-grained sand, and gravel with silt and clay at IRP Site 6. **Figure 1-7** illustrates a generalized geologic cross-section for IRP Site 3.

1.6 HYDROGEOLOGY

The hydrogeologic framework within the Atlantic Coastal Plain consists of a series of aquifers and semi-confining to confining units. In the AC Region, three of these aquifers are of particular concern. The shallow or water table aquifer is the Cohansey Sand, the Kirkwood-Cohansey Aquifer System, and the AC Aquifer (Kirkwood Formation). The deeper aquifers (Eocene, Paleocene, and Cretaceous-age) are typically not accessed in the Atlantic City area due to high salinity and generally poor water quality (SCITEK, 1989). Aquifer characteristics reported in the Final RI for Sites 3 and 6 include:

- IRP Site 3
 - hydraulic conductivities in wells ranging from 1.27×10^{-4} to 2.62×10^{-2} centimeters per second (cm/sec) with a geometric mean in shallow wells of 3.963×10^{-3} cm/sec;
 - hydraulic gradient ranging from approximately 0.0036 to 0.012 ft/ft with an average of 0.0086 ft/ft; and,
 - groundwater flow to the southeast.
- IRP Site 6
 - groundwater velocity of approximately 17 meters/year, or 56 ft/year;
 - hydraulic gradient of 0.0031 ft/ft; and,
 - groundwater flow to the southeast.



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**FIGURE 1-7
IRP Site 3 Generalized Geologic Cross Section**

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Egg Harbor Township, New Jersey

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1.6.1 Public Supply Wells

Atlantic City obtains its municipal water supply from the Atlantic City Municipal Utilities Authority via nine production wells, which are located north of the Upper Atlantic City Reservoir, on the FAA property. These wells obtain their water from the Lower Cohansey aquifer. This water supply is supplemented by water withdrawn directly from the Upper and Lower Atlantic City Reservoirs. The upper reservoir lies entirely within FAA property, whereas the lower reservoir is situated just outside of the FAA property, to the east. The reservoirs are fed by the North and South Branches of Doughty's Mill Stream, which traverse portions of the FAA property. The South Branch of Doughty's Mill Stream also flows through the FAA property within a short distance of the southern perimeter of the NJANG Base (TRC 1986).

Potable water in the vicinity of Base is obtained in part from the Cohansey Sand (ABB 1995, TRC 2003). The Middle Cohansey Sand is approximately 80 ft to 90 ft bgs and is utilized primarily for domestic water supply. The Lower Cohansey Sand, located at 150 ft to 200 ft bgs, is tapped for municipal and commercial use. Although the Middle and Lower Cohansey are hydraulically connected regionally, evidence from pumping wells indicates that the Lower Cohansey sand is hydraulically isolated from the Upper Cohansey, or water table aquifer at the Base (SCITEK, 1989).

1.7 NATURE AND EXTENT OF CONTAMINATION

The RI findings with regard to analytical data and nature and extent of contamination at IRP Sites 3 and 6 are summarized in the following sections.

1.7.1 IRP Site 3

Groundwater data collected during the RI included definitive data (off-site laboratory analysis) obtained from monitoring wells and groundwater screening data (mobile laboratory analysis) collected during a direct push field investigation. Although the direct push data are regarded as screening data, the results are included in the nature and extent discussion to provide a more comprehensive evaluation of the distribution of COCs in the shallow groundwater. Groundwater samples collected from permanent monitoring wells and during the direct push investigation were analyzed for VOCs, while only samples collected from monitoring wells were additionally analyzed for metals and natural attenuation parameters.

Groundwater data were compared to the NJDEP GWQS, as outlined in N.J.A.C. 7:9-6, January 7, 1993 and recodified with amendments, November 7, 2005 (Chapter 7:9c, Ground Water Quality Standards). Groundwater within the NJANG is classified as Class I-PL (Preservation Area) under N.J.A.C. 7:9C. Therefore, the NJDEP GWQS applicable to the Site are the background concentrations or, in cases where information on background concentrations is not available, the corresponding PQLs. Detailed data analysis can be found in the Final RI (ANG, 2011) and for reference, historical data tables are include as **Appendix B**.

*located in the Coastal Plain
sole
source
Aquifer*

Although soils data were collected during previous investigations at IRP Site 3, concentrations of constituents were all below the NJDEP RDCSRS. Therefore, additional response actions associated with soil at IRP Site 3 are not considered in the FS.

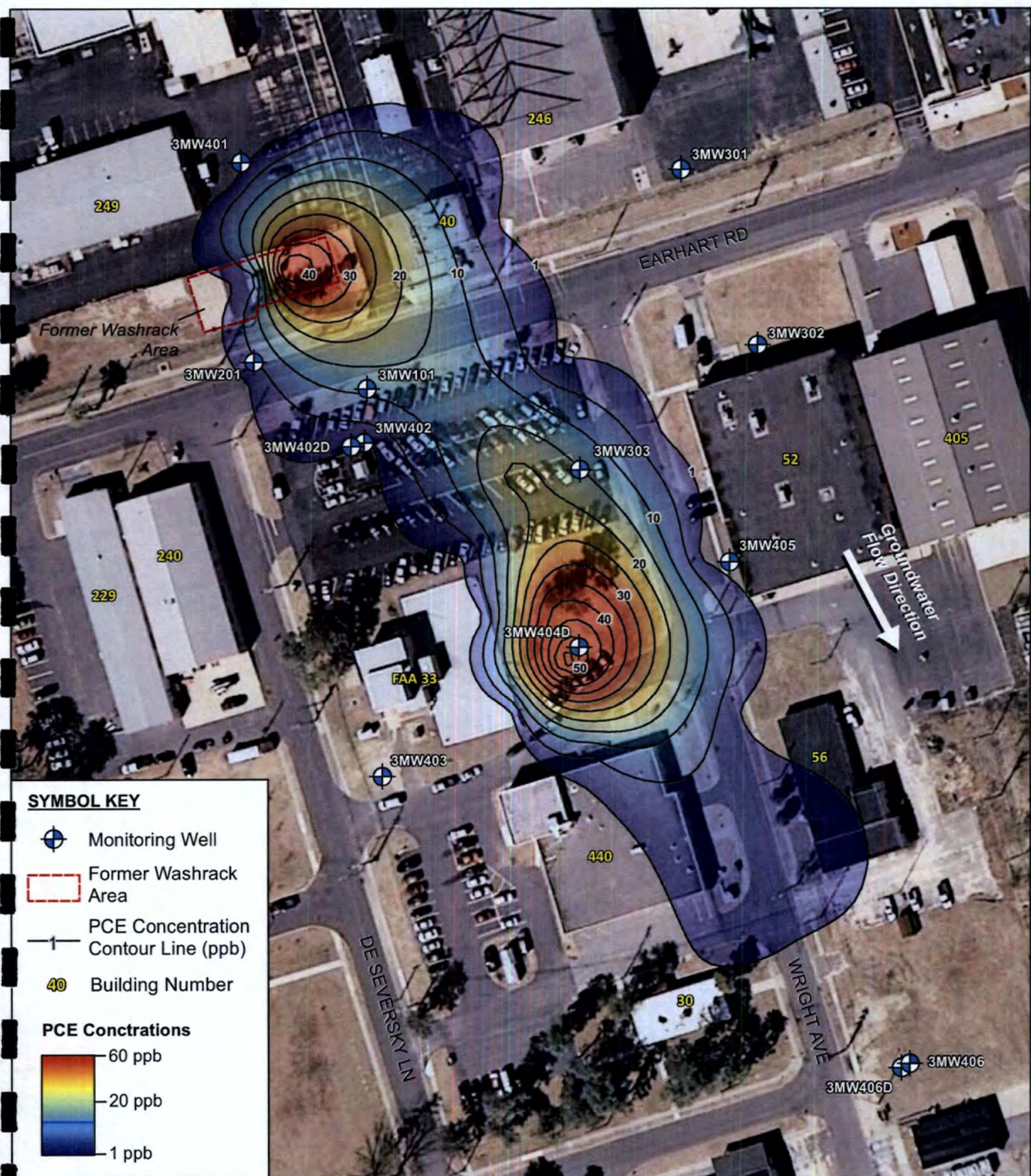
Organic Compounds: The organic dissolved-phase constituents detected at concentrations exceeding the NJDEP GWQS and identified in the Human Health Risk Assessment (HHRA) as COCs included tetrachloroethene (PCE), chloroform and naphthalene for IRP Site 3 (**Appendix B**). The observed shallow groundwater plume geometry based on these COCs generally extend from approximately 18 to 60 ft bgs (**Figures 1-8 and 1-9**) and extends approximately 550 ft horizontally from the former wash rack area towards the southeast. Within the deeper portion of the shallow aquifer, (3MW402D and 3MW406D) chloroform was observed at concentrations exceeding the GWQS. Data collected from the monitoring wells indicate that PCE exceeds the 1 µg/l PQL at a maximum detected concentration of 7.96 µg/l. Screening level data indicate a maximum PCE concentration of 59 µg/l.

COCs occur in the dissolved-phase [i.e., no evidence has been found to suggest the presence of a dense non-aqueous phase liquid (DNAPL) or LNAPL at the site]. Further, observed constituent concentrations are not consistent with a continuing DNAPL or LNAPL source.

Inorganic Compounds: Inorganic compounds that were previously detected in unfiltered groundwater samples at concentrations exceeding the NJDEP PQLs included arsenic, cadmium, chromium, lead, mercury, aluminum, iron, sodium and selenium (**Appendix B**). However, the results for each of these parameters except sodium and selenium were within the background ranges determined during site-specific and/or regional background investigations. Further, the reported detection of selenium in a single well during the July 2006 sampling event was not confirmed by subsequent sampling results, and sodium commonly occurs as a regional groundwater contaminant as a result of the use of salt for de-icing of roadways. Additionally, the spatial distribution of analytical results for metals does not suggest a pattern that is indicative of a localized discharge. Therefore, while the presence of metals was considered in the development of potential remedial alternatives for IRP Site 3 (*i.e.* to ensure that the remedies do not enhance metal mobility in the environment), active remediation of metals in groundwater is not proposed.

1.7.2 IRP Site 6

During the RI, site soils were investigated to determine potential impacts based on historical use. The soil analytical data were compared to the NJDEP RDCSRS (NJDEP 2009). Constituent concentrations detected in soil exceeding the RDCSRS included organic and inorganic constituents.

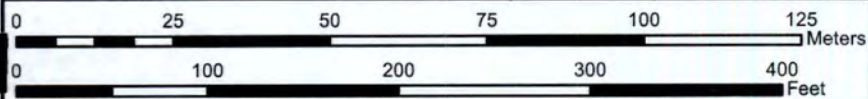


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**FIGURE 1-8
IRP Site 3 Tetrachloroethene (PCE)
Concentrations in Groundwater**

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177th Fighter Wing, Egg Harbor Township, New Jersey

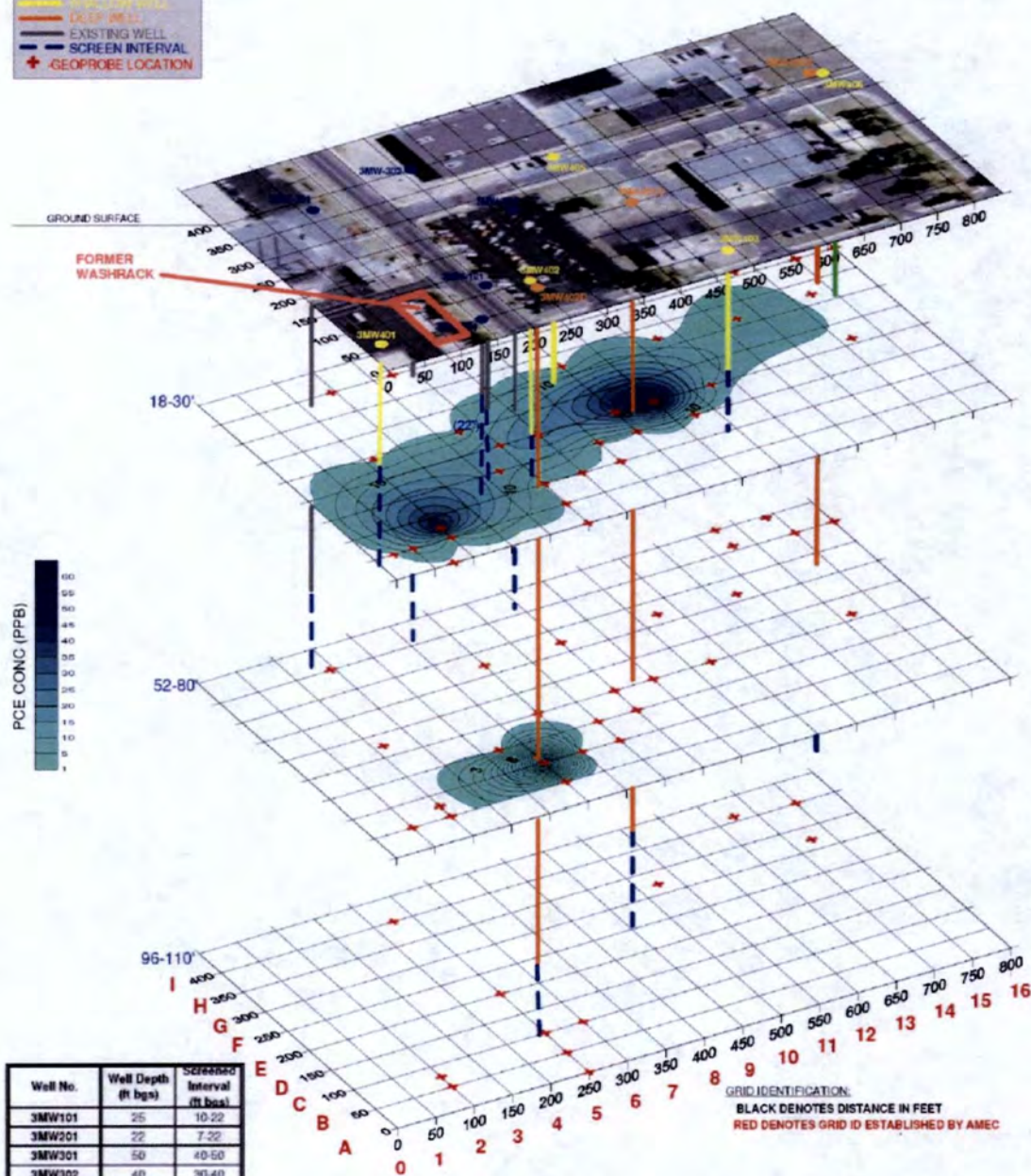


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FIGURE 1-9
IRP Site 3 3-D Tetrachlorethene (PCE)
Concentrations in Groundwater

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177th Fighter Wing, Egg Harbor Township, New Jersey

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Although groundwater data was collected during previous investigations at IRP Site 6, concentrations of constituents were all below the NJDEP GWQS. Therefore, additional response actions associated with groundwater at IRP Site 6 are not considered in the FS.

Organic Compounds: The organic contaminants detected at concentrations exceeding the NJRDCSRS in soil and identified in the HHRA as COCs for IRP Site 6 include benzo(a)pyrene (BaP) and dibenz(a,h)anthracene (DbA). The distribution on SVOCs is generally confined to 1 ft bgs and found adjacent to the former test pad (**Figure 1-10**). One isolated area of impact located east of the blast pad and beyond the footprint of the former test cell Trailer, was identified based on data collected from SS-05 where BaP was reported at a concentration (0.533 milligrams per kilogram [mg/kg]) exceeding the NJRDCSRS of 0.2 mg/kg. A background study for PAHs was not conducted for IRP Site 6.

Metals: Lead was detected in all soil samples collected at IRP Site 6, however, all concentrations were below the NJRDCSRS. Three samples exhibited concentrations above the NJDEP SRS IGW Soil Screening Level of 59 mg/kg. The soils above the NJDEP IGW for lead lie within the footprint of the SVOC soils impact area and are confined to the 0-0.5ft interval. A background study for metals was not conducted for IRP Site 6.

1.8 CONTAMINANT FATE AND TRANSPORT

This section provides a brief summary of the COC fate and transport at IRP Sites 3 and 6. The RI Report (ANG, 2011) provides additional detailed information related to the contaminant fate and transport mechanisms and pathways for the identified COCs.

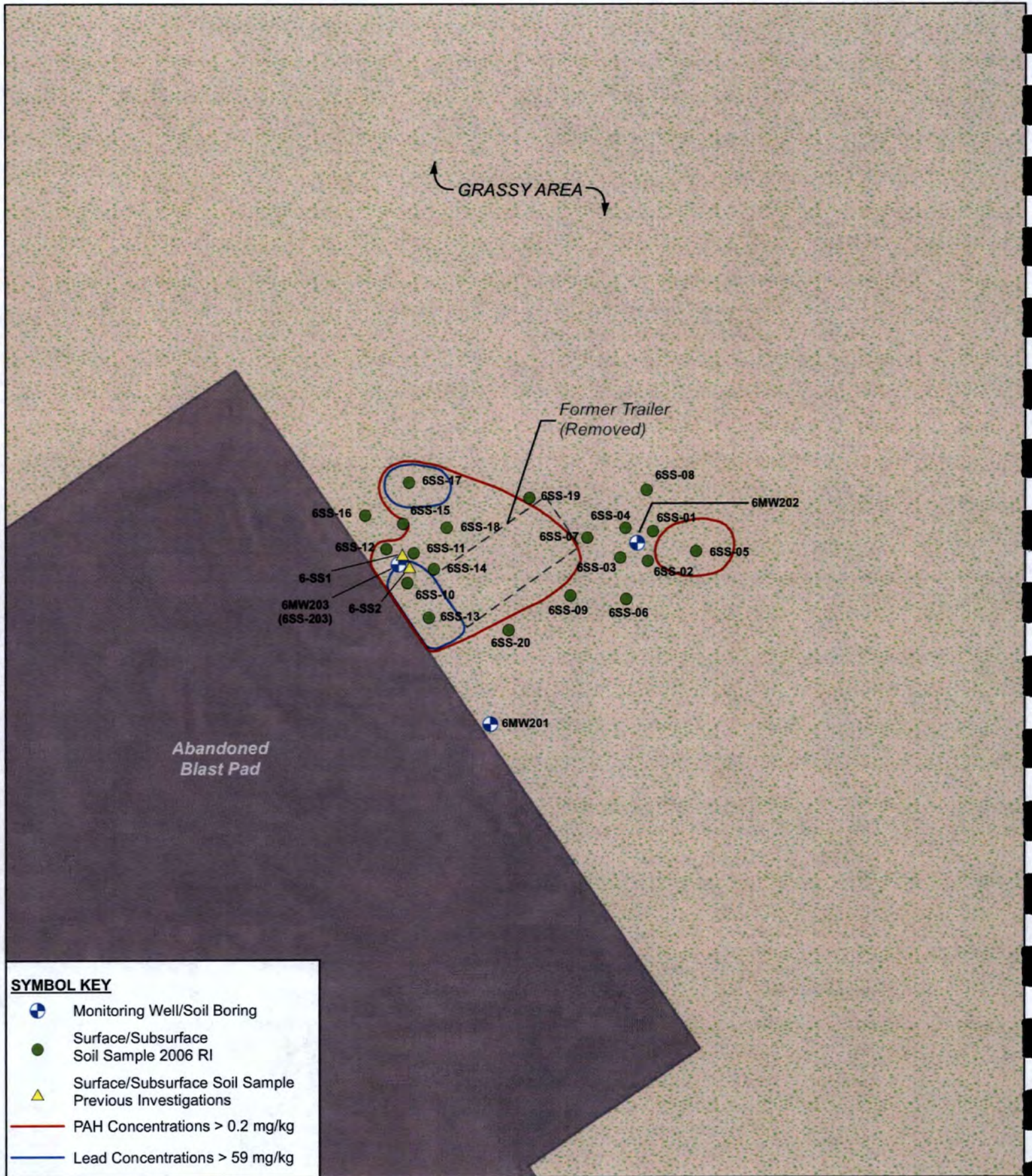
The transport and transformation processes applicable to COCs at IRP Sites 3 and 6 are:

- Physical transport – which occurs when chemicals volatilize from soil or groundwater and diffuse into pore spaces or into the atmosphere.
- Chemical transformation – which involves natural chemical reactions in soil or groundwater to change the structure of the compounds (e.g., sorption, biodegradation).

1.8.1 IRP Site 3

In order to evaluate the adsorption/dispersion of the PCE plume, the BIOCHLOR Natural Attenuation Decision Support System, Version 2.2 (USEPA, 2002) groundwater modeling tool was used. The program, published by the USEPA, is based on the Domenico and Schwartz analytical solute transport model. The software is capable of simulating one-dimensional advection, three-dimensional dispersion, linear adsorption, and biotransformation via reductive dechlorination.

Natural attenuation parameters were measured during the RI (ANG, 2011) to determine the site-specific groundwater geochemical characteristics. **Table 1-1** presents a summary of those geochemical parameters measured.



SYMBOL KEY

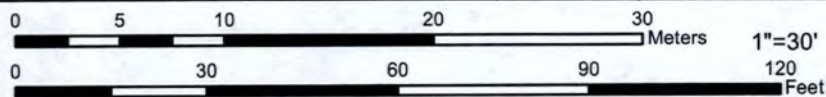
- Monitoring Well/Soil Boring
- Surface/Subsurface Soil Sample 2006 RI
- Surface/Subsurface Soil Sample Previous Investigations
- PAH Concentrations > 0.2 mg/kg
- Lead Concentrations > 59 mg/kg

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FIGURE 1-10 IRP Site 6 SVOC and Lead Concentrations in Soil

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Table 1-1. Natural Attenuation Parameters at Site 3

Natural Attenuation Parameter*	Range	Optimal Concentration/Range for Biodegradation	Conditions at IRP Site 3
Nitrates	0.808 - 9.58 mg/l	At <1 mg/l, will not compete with reductive pathway	Conditions not favorable in most samples collected.
Sulfates	ND - 44.2 mg/l (70% <20 mg/l)	At <20 mg/l, will not compete with reductive pathway	Conditions may be favorable.
Dissolved Ferrous Iron	ND - 0.7 mg/l	Reductive pathway possible at >1 mg/l	Conditions not favorable.
TOC	ND - 1.24 mg/l	> 20 mg/l, TOC drives dechlorination as a carbon and energy source	Conditions not favorable.
DO	0.22 - 8.87 mg/l	Tolerated at <0.5 mg/l	Conditions not favorable in most samples collected (DO was found at <0.5 mg/l in less than 10% of samples collected).
ORP	133 - 393 millivolts (mV)	Reductive pathway possible at <50 (mV)	Conditions not favorable.
pH	3.65 - 6.4 (75% <5)	5 < pH < 9	Conditions not favorable as >50% of samples were <5.
TCE	ND - 4.8 µg/l	Detection represents PCE daughter products	Conditions cannot be determined. Concentrations of TCE found are relatively low and were found on the outskirts of the plume rather than in areas of PCE concentrations > 20µg/l.
cis-1,2 DCE	ND	Detection represents daughter products	Lack of daughter products indicates unfavorable conditions.
VC	ND	Detection represents daughter products	Lack of daughter products indicates unfavorable conditions.

*Samples collected during RI fieldwork in 2006.

The site-specific geochemical parameters presented in **Table 1-1** are an important indication of the aquifer conditions and the site's ability to naturally biodegrade the dissolved-phase PCE contaminant plume. Typically, PCE is biodegraded under natural conditions via reductive dechlorination. Site 3 is characterized by inadequate concentrations of native and/or anthropogenic carbon (TOC) and concentrations of dissolved oxygen (DO) that are greater than 0.5 milligrams per liter (mg/l). In addition, the majority of the other monitored natural attenuation (MNA) parameters indicate that the conditions at Site 3 are not favorable for significant natural reductive dechlorination of the PCE contaminant plume. As such, the model was evaluated using only the BIOCHLOR solute transport without the biotransformation process to predict future conditions. Current Site conditions were input in the model and MNA via advection, dispersion, adsorption and biotransformation processes was evaluated. The simulation was then allowed to extend to evaluate future conditions. A copy of this simulation is included as **Appendix C** and a brief summary of the input parameters and results is provided below.

1.8.1.1 BIOCHLOR Input Parameters

The four main components affecting the fate and transport of the PCE plume are adsorption, advection, dispersion, and biotransformation. Input parameters used for the PCE plume are a combination of field-based data and literature values.

Adsorption: Adsorption is the binding of molecules or particles to a surface. Retardation is a direct result of adsorption. The retardation factor (R) is the ratio of the groundwater seepage velocity to the rate that organic chemicals migrate in the groundwater, and is represented in the following equation:

$$R = 1 + \frac{K_d \rho_b}{n}$$

where $K_d = K_{oc} + f_{oc}$. Input parameters for adsorption include the distribution coefficient (K_d), Soil Bulk Density (ρ_b), Fraction Organic Carbon (f_{oc}), and a chemical-specific Partition Coefficient (K_{oc}).

A ρ_b value of 1.7 grams per cubic centimeter (or 1.7 kilograms per liter) was used. This is the default value in the BIOCHLOR model, but is typical for sandy soils. f_{oc} is the fraction of the aquifer soil matrix comprised of natural organic carbon in the uncontaminated areas. Higher f_{oc} values correlate to more adsorption of PCE to the aquifer matrix. Since this data is not available for PCE, the BIOCHLOR default value of 0.001 was used. A K_{oc} value of 426 L/kg (BIOCHLOR default value) was selected. The values for ρ_b , f_{oc} , and K_{oc} resulted in a retardation factor for PCE of 3.41, which indicates that the velocity of the PCE is 3.41 times slower than the groundwater itself.

Advection: Advection describes the hydraulic characteristics and movement of the contaminant as it is transported through the aquifer and is used in conjunction with the retardation factor (3.41) to determine the flow of the PCE plume. Advective flow velocities, or seepage velocities, are based on the average (bulk) properties of the aquifer materials (hydraulic conductivity and effective porosity) and the average hydraulic gradient causing flow.

The hydraulic gradient (i) and hydraulic conductivities (K) are typically based on actual field data. Using data collected during the RI (ANG, 2011), the estimated hydraulic gradient (calculated by averaging the hydraulic gradients within the PCE plume) is 0.0086. The effective porosity (η_e) for sandy soils range from 28 to 32% (Kruseman, G.P. and de Ridder, N.A., 1994). An average effective porosity of 30% was used based on the range of porosities estimated to be present in the soils. A hydraulic conductivity of 3.963×10^{-3} cm/sec was calculated using the geometric mean of shallow well data from the RI (ANG, 2011). Using the equation for seepage velocity (V_s) below, these values generate a seepage velocity of 117.5 ft/year.

$$V_s = \frac{\eta_e}{K * i}$$

Dispersion: Dispersion is the process whereby a dissolved solvent will be spatially distributed longitudinally, transversely and vertically due to mechanical mixing and chemical diffusion in the aquifer. BIOCHLOR input parameters for dispersion are Longitudinal Dispersivity (α_x) (ft), Transverse Dispersivity (α_y) and Vertical Dispersivity (α_z). Since there are two “hotspots” within the plume, each was modeled separately. Hotspot 1 (to the north in the former washrack area), assumes a plume length of 650 feet. Hotspot 2 (just east of Building FAA 33) assumes a plume length of 282 feet. Using these lengths and the Xu and Eckstein method (Xu/Eckstein, 1995), the dispersion coefficients were approximated based on groundwater concentrations obtained during the RI (ANG, 2011) and the corresponding plume maps produced. Dispersion in the z (vertical) direction was ignored since a two-dimensional model was being simulated, and the migration of the contaminant in the x-y direction is of primary concern.

Biotransformation: Biotransformation data is dependent on the concentration of the contaminant and the first-order decay coefficients. However, there is no apparent evidence of biotransformation in the aquifer at Site 3 (i.e., no measureable presence of PCE daughter products). Therefore, biotransformation was not modeled.

General Parameters: The simulation time for each model was set at an arbitrary 100 years. The modeled plume size for Hotspot 1 was set at 650 ft long by 100 ft wide. Hotspot 2 was defined as 131 ft wide and 282 ft long.

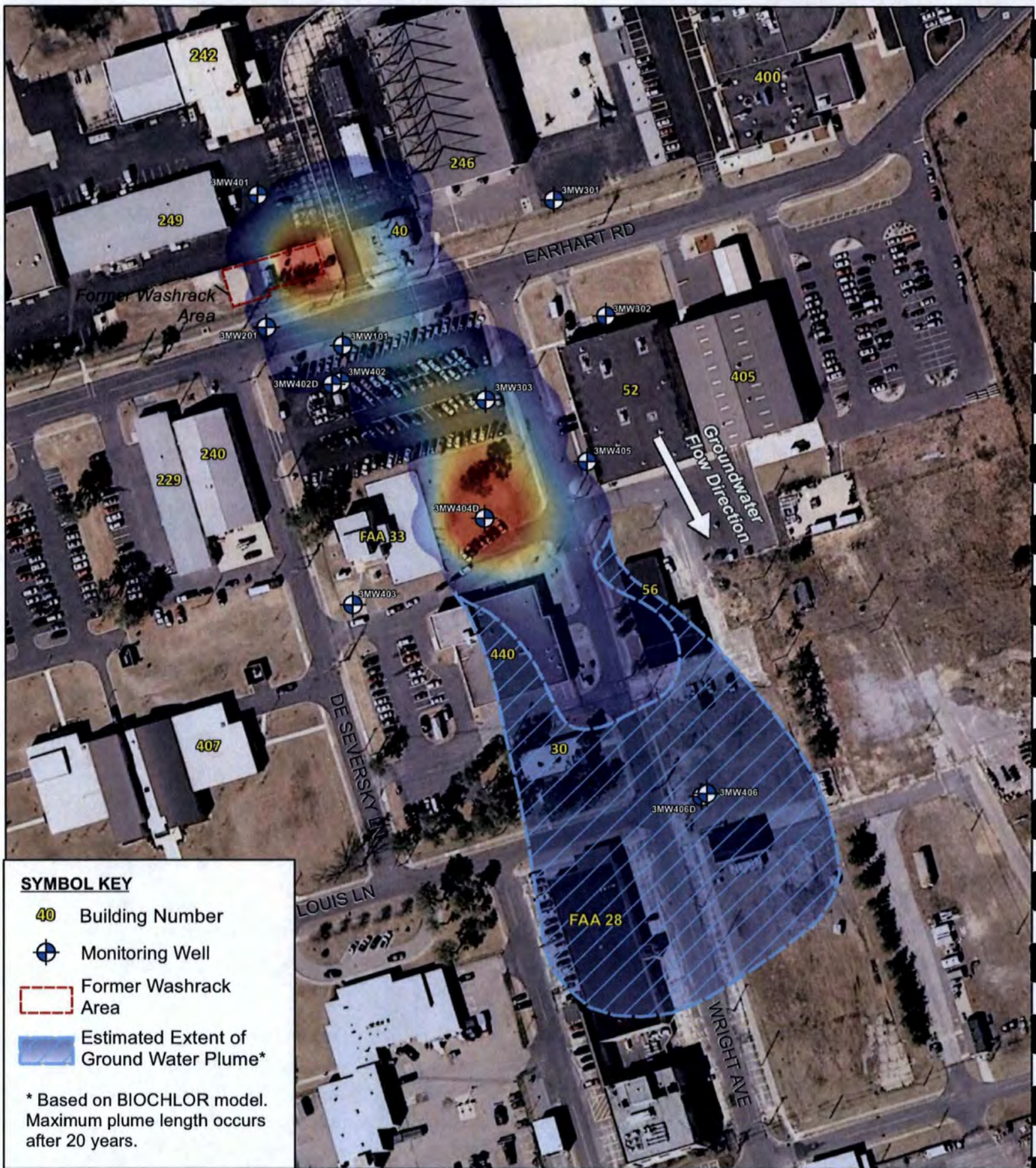
Source Data: This section describes the physical and chemical characteristics of the PCE source area. These data represent the initial conditions after the contaminant release, and the concentrations selected will affect plume concentrations down gradient.

While biotransformation was not modeled, a very low source decay constant (0.01/yr) was incorporated into the model to account for gradual source depletion over time. The source thickness was estimated to be 45 ft at Hotspot 1 and 20 ft at Hotspot 2. The source widths were estimated to be 100 and 131 feet, respectively. These dimensions are based on the estimated plume dimensions found during the RI (ANG, 2011).

Contaminant concentrations were modeled as a single planar source with a maximum PCE concentration of 59 $\mu\text{g/l}$. This conservative concentration was used as it was the highest concentration detected during the direct push investigation.

1.8.1.2 Results

The results of the BIOCHLOR groundwater modeling tool indicate that: 1) PCE will reach cleanup levels (1 $\mu\text{g/l}$) in approximately 40 years; and, 2) the plume length will increase by approximately 300 feet if no remedial action is taken. The maximum plume length (shown on **Figure 1-11**) will result after an estimated 20 years. It should be noted that the BIOCHLOR model was used as a tool for screening the effectiveness of natural attenuation of the PCE plume as a basis for evaluating FS alternatives. This estimate can be considered to be conservative,

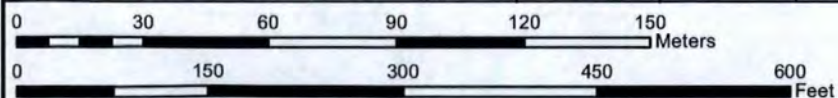


SYMBOL KEY

- 40** Building Number
- Monitoring Well
- Former Washrack Area
- Estimated Extent of Ground Water Plume*

* Based on BIOCHLOR model. Maximum plume length occurs after 20 years.

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**FIGURE 1-11
IRP Site 3 Estimated Extent
of Ground Water Plume**

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given that other natural attenuation processes (*e.g.*, volatilization, hydrolysis etc.), would further attenuate chemical concentrations within groundwater.

1.8.2 IRP Site 6

In soil, polynuclear aromatic hydrocarbons (PAHs) have a strong affinity for sorption and a relatively low water solubility indicating that these compounds may not leach into the groundwater. This was corroborated by the fact that PAHs were not detected in the associated groundwater samples.

1.9 BASELINE RISK ASSESSMENT

The conclusions presented in **Table 1-2** were provided in the Final RI Report regarding the HHRA and Screening Level Ecological Risk Assessment performed for IRP Sites 3 and 6:

Table 1-2. COCs Identified During the Baseline Risk Assessment

Site	Media	Constituent	Risk Assessment Summary
IRP Site 3	Soil	None	<ul style="list-style-type: none"> No COCs were identified for Site soil.
	Ground-water	Chloroform, naphthalene, PCE	<ul style="list-style-type: none"> Human health exposure pathways include ingestion and inhalation. COCs detected in groundwater monitoring wells at Site 3 have not impacted potable wells located outside the Base perimeter fence, side-gradient to existing monitoring wells. HHRA and fate and transport modeling indicated COCs would naturally attenuate to concentrations less than the NJDEP GWQS at a rate such that they will not intercepting drinking water wells. Vapor intrusion is not a significant exposure pathway, as the maximum VOC concentrations in groundwater do not exceed target groundwater concentrations corresponding to target indoor air concentrations. The groundwater discharge to surface water pathway at Site 3 is not complete. Site 3 does not constitute ecological habitat.
IRP Site 6	Soil	BaP, DbA, lead	<ul style="list-style-type: none"> Human health exposure pathways include incidental ingestion and dermal contact with soils and inhalation of airborne particulates. Contaminants of potential ecological concern include PAHs and lead in soil. Risk estimates for exposure to BaP and DbA for current site workers exceed the USEPA threshold of 1×10^{-6}, based on a monthly exposure for five years.
	Ground-water	None	<ul style="list-style-type: none"> No COCs were identified for groundwater.

1.10 APPROPRIATE, RELEVANT, AND APPLICABLE REQUIREMENTS

Appropriate, Relevant, and Applicable Requirements (ARARs) addressing contaminated environmental media are identified in this and the following subsections. The NCP (40 CFR 300) defines “applicable” requirements as: “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance found at a CERCLA

site.” Only those promulgated state standards identified by a state in a timely manner that are substantive and equally or more stringent than federal requirements may be applicable.

The NCP further defines “relevant and appropriate” requirements as: “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that, while not ‘applicable’ to a hazardous substance, pollutant, contaminant, removal action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.” Like “applicable” requirements, the NCP also provides that only those promulgated state requirements identified in a timely manner and are more stringent than corresponding federal requirements may be relevant and appropriate. The USEPA identifies three basic types of ARARs including chemical-specific, action-specific, and location-specific.

1.10.1 Chemical-Specific ARARs

Chemical-specific ARARs govern the extent of site cleanup by providing cleanup levels or a basis for calculating cleanup levels. For example, the NJDCSRS for soil may be selected as the cleanup goals for the COCs for the site. Based on this scenario, chemical-specific ARARs may be used to indicate acceptable criteria for establishing remediation and disposal requirements for assessing the effectiveness of removal action alternatives. Thus, chemical-specific ARARs establish acceptable concentrations of constituents in various media. The chemical specific ARARs for the sites are presented in **Table 1-3**.

The chemical-specific ARARs identified for the remedial alternatives are the *NJDEP GWQS* (http://www.nj.gov/dep/wms/bwqsa/Appendix_Table_1.htm) and the *NJDEP SRS* (September 2009; <http://www.nj.gov/dep/standards/soil%20report.pdf>). The cleanup goals used for the evaluation of remedial alternatives are summarized on **Table 1-4**.

The USEPA’s groundwater policy designates aquifers as Class I, Class II, and Class III based on the current or potential use of the aquifer. The groundwater located under the entire Base is classified as a sole source aquifer. That designation confers at least a Class IIA current source of drinking water classification. The NCP states that: “USEPA expects to return usable groundwaters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.” (40 CFR Section 300.430(a)(1)(iii)(F)). The beneficial use of groundwater at the ANG sites is drinking water. Therefore drinking water standards such as state and federal maximum contaminant levels (MCLs) are ARARs, as well as NJDEP GWQS for Class PL-I (Protection Area) groundwater. USEPA guidance states that when there is more than one chemical-specific ARAR that addresses a particular medium, that the most stringent (lowest) standard be used as the cleanup level.

Table 1-3. Chemical Specific ARARs

REQUIREMENT	EXPLANATION	STATUS
FEDERAL ARARs		
Clean Air Act (42 USC 7101) National Ambient Air Quality Standards (NAAQS) National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61 .60-60.7 1)	NAAQS are primary (health-based) and secondary (welfare-based) standards for air quality. NESHAP are emission levels for certain hazardous air pollutants. Remedial actions resulting in air emissions may consider these standards.	Relevant and Appropriate
Clean Water Act (33 USC 1251 - 1376) Ambient Water Quality Criteria (AWQC) (40 CFR 131)	AWQC protect aquatic life and human health. AWQC include 1) health-based criteria for carcinogenic and non-carcinogenic compounds; and 2) water quality parameters. AWQC are associated with human exposure to drinking water and fish consumption.	Relevant and Appropriate
Reference Dose (RfD), USEPA Office of Research and Development Cancer Slope Factor, USEPA Environmental Criteria and Assessment Office, USEPA Carcinogen Assessment Group Health Advisories, USEPA Office of Drinking Water Health Effects Assessments, USEPA Environmental Criteria and Assessment Office USEPA Regional Screening Levels	These criteria are used during risk-based screening and the risk assessment to evaluate risks posed to human health by site conditions. Maximum exposure concentrations established during the risk assessment will be considered during identification and evaluation of remedial alternatives.	Applicable
Safe Drinking Water Act (SDWA) (42 United States Code (USC) 300) Maximum Contaminant Level (MCL) - (40 CFR 141) Maximum Contaminant Level Goal (MCLG)	SDWA regulates the concentration of chemicals in public drinking water supplies. MCLs have been promulgated for several common organic and inorganic compounds. MCLGs are levels at which there are no known or anticipated public health effects.	Relevant and Appropriate

Table 1-4. IRP Site 3 and IRP Site 6 Cleanup Criteria

Constituent	Media	Clean-Up Criteria
IRP Site 3^a		
PCE	Groundwater	1 µg/l
Chloroform	Groundwater	1 µg/l
Naphthalene	Groundwater	2 µg/l
IRP Site 6^b		
Benzo(a)pyrene	Soil	0.2 mg/kg
Dibenz(a,h)anthracene	Soil	0.2 mg/kg
Lead	Soil	59 mg/kg

^a NJDEP Groundwater Quality Criteria

^b NJDEP Soil Remediation Standards

The Brownfield and Contaminated Site Remediation Act ("Brownfield Act"), at N.J.S.A. 58:10B-12(a), directs the Department to adopt minimum remediation standards for soil, groundwater, and surface water necessary for the remediation of contaminated sites. Consistent with this legislative directive, the Department previously established remediation standards for surface water and ground water, which are codified in the Technical Rules for Site Remediation, N.J.A.C. 7:26E (the Technical Rules), at N.J.A.C. 7:26E-1.13. The Technical Rules set forth the minimum requirements for the remediation of every contaminated site in New Jersey, including both the methodology that must be followed and the standards to which groundwater and surface water must be remediated.

1.10.2 Location-Specific ARARs

Location-specific ARARs pertain to existing site features. Location-specific ARARs place restrictions on constituent concentrations or remedial/removal activities solely based on site setting or location (e.g., within or adjacent to wetlands, floodplains, existing landfills, disposal areas, and places of historical or archeological significance). Location-specific ARARs place restrictions on remedial actions due to site location, such as if a site were located in a wetland or if it would interfere with an active Base mission.

Potential location-specific ARARs that are applicable or relevant and appropriate for these IRP Sites are listed in **Table 1-5**.

1.10.3 Action-Specific ARARs

Action-specific ARARs pertain to proposed site remedial actions and govern implementation of the selected site remedy. Action-specific ARARs set controls or restrictions on activities related to the management of contaminated and/or hazardous materials. After remedial action alternatives are developed, action-specific ARARs pertaining to proposed site remedies provide a basis for assessing their feasibility and effectiveness. For example, action-specific ARARs may include hazardous waste management requirements, air and water emission standards, and Resource Conservation and Recovery Act (RCRA) landfill requirements. Potential action-specific ARARs that are applicable or relevant and appropriate are included in **Table 1-6**.

Table 1-5. Location Specific ARARs

REQUIREMENT	EXPLANATION	STATUS
FEDERAL ARARs		
Endangered Species Act of 1973 (16 USC 1351)	Requires action to conserve and protect endangered species within critical habitats.	Applicable
National Environmental Protection Act (40 CFR 6, Appendix A)	Degradation, loss, and destruction of environmental quality, including wetlands and floodplains, should be minimized during remedial actions.	Relevant and Appropriate
STATE ARARs		
N.J.S.A - Water Quality Planning Act 58:11A-9 to A-16	These statutes provide for the municipal regulation of various activities in aquifer protection areas.	Applicable
N.J.S.A. - New Jersey Water Pollution Control Act Title 58:10A-4	This statute authorizes the commissioner of public health to investigate pollution or threatened pollution of a public water supply system or source.	Relevant and Appropriate
N.J.S.A. - Brownfield and Contaminated Site Remediation 58:10B-2 and 58:10B-12.	These regulations provide specific numeric remediation criteria for a wide variety of contaminants in soil and groundwater. Separate soil criteria address threats to human health and environmental receptors posed by direct contact with contaminants and by pollutant mobility to groundwater. In addition, criteria are provided for groundwater quality and for risks to human and environmental receptors posed by migration of contaminants via ground water or soil vapor. The regulations include provisions for adoption of alternative criteria and alternative means for determining compliance; and a procedure for establishing criteria where none exist. The regulations provide for varied remediation criteria based on land use and pollutant accessibility, provided these are ensured through land use restrictions on the property record.	Applicable
N.J.A.C. - Pinelands Comprehensive Management Plan 7:50	These regulations and standards promote the orderly development of the Pinelands to preserve and protect the significant and unique natural, ecological, agricultural, archaeological, historical, scenic, cultural and recreational resources of the Pinelands.	Relevant and Appropriate

Table 1-6. Action Specific ARARs

REQUIREMENT	EXPLANATION	STATUS
FEDERAL ARARs		
Hazardous Waste Requirements (RCRA Subtitle C, 40 CFR Part 264)	This act establishes standards applicable to treating, storing, and disposing of hazardous wastes. The act has numerous subparts that cover such areas as: (a) Releases from Solid Waste Management Units; (b) Closure and Post-Closure of Hazardous Waste Facilities; Generators; Waste Piles; Incinerators; and (c) Land Disposal Restrictions; Miscellaneous Units and Transporters.	Applicable
Occupational Safety and Health Act (OSHA) Requirements (29 CFR Parts 1910, 1926, and 1904)	Health and safety requirements for workers engaged in on-site remedial activities are established under this act.	Applicable
Threshold Limit Values, American Conference of Governmental Industrial Hygienists	Values established for air concentrations during remedial activities are enforced through OSHA (above).	Applicable
Clean Air Act (42 USC 7101) National Ambient Air Quality Standards (NAAQS) National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61.60-60.71)	NAAQS are primary (health-based) and secondary (welfare-based) standards for air quality. NESHAP are emission levels for certain hazardous air pollutants. Remedial actions resulting in air emissions may consider these standards.	Applicable
Federal Department of Transportation Rules for Hazardous Materials Transport (40 CFR Parts 107, 171.1 - 500)	When remedial actions include offsite treatment and disposal, transport is regulated by these acts.	Applicable
Clean Water Act (33 USC 1251 - 1376). National Pollution Discharge Elimination System (NPDES) Permits (40 CFR I 22) 404(b)(1) Dredge and Fill Permits	Remedial actions resulting in the discharge of dredged or fill materials into waters of the United States are regulated under this act. NPDES permits are required for the discharge of any point source into waters of the United States.	Relevant and Appropriate
Regulation of Activities Affecting Water of the United States (33 CFR Parts 320-329)	These regulations apply to actions affecting wetlands and navigable waters (Section 10, Waters).	Relevant and Appropriate
National Environmental Policy Act of 1969	Degradation, loss, and destruction of wetlands and floodplains should be minimized during remedial actions	Relevant and Appropriate
STATE ARARs		
N.J.A.C. - Air Pollution Control - Operating Permits 7:27-22	This regulation requires permits to construct and operate stationary sources of emissions, and requires those sources to meet specified standards. Pollution abatement controls may be required. Specific standards are listed for many pollutants.	Relevant and Appropriate
N.J.A.C. - Air Pollution Control - Control and Prohibition of Air Pollution by Volatile Organic Compounds 7:27-16	This subsection sets standards for emission of organic compounds.	Applicable

*Offsite Disposal
Rule 20
NCP Section 300.440*

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The NCP requires the remedial alternative development process to be initiated by developing RAOs, identifying GRAs that address the RAOs, and performing an initial screening of applicable remedial technologies and process options. The following sections detail these activities.

Development of RAOs and GRAs, as defined by USEPA, consist of medium-specific or operable unit-specific goals for protecting human health and the environment (USEPA, 1988). Once RAOs have been established, GRAs must be identified which are broad approaches of remedial measures that can potentially achieve RAOs. GRAs may encompass many remedial technologies and remedial technology process options. For example, in-situ treatment is a GRA; physical treatment is a remedial technology; and air sparging is a remedial technology process option.

2.1 IRP SITE 3

In order to develop a RAO for IRP Site 3, an evaluation was conducted to determine the general cost/benefit of actively treating higher concentration target areas ($>20 \mu\text{g/l}$) of the PCE plume. In the first case, it was assumed that no treatment would be implemented and that the concentrations of PCE would remain at $59 \mu\text{g/l}$. The remaining three options assume that an active treatment would be used to reduce concentrations of PCE to either $20 \mu\text{g/l}$, $10 \mu\text{g/l}$, or $1 \mu\text{g/l}$. The BIOCHLOR model was used to determine the estimated time needed for MNA to reduce PCE concentrations to $1 \mu\text{g/l}$ for each option. The simulations for each concentration used in the BIOCHLOR model are provided in **Appendix C**.

As a general rule of thumb, cleanup timeframes of greater than 30 years is typically not considered acceptable when evaluating remedial alternatives. Therefore, **Table 2-1** indicates some type of active treatment will be required to achieve the RAOs within a 30-year timeframe. When evaluating the remaining three options of treating areas of the plume with concentrations higher than $20 \mu\text{g/l}$, $10 \mu\text{g/l}$, or $1 \mu\text{g/l}$, cost and the estimated time to reach cleanup criteria, and risk to potential receptors were considered. At IRP Site 3, there is relatively little risk to receptors and the groundwater plume is not expected to migrate off-Base based on the BIOCHLOR modeling presented in Section 1.8.1. Therefore, it was determined that an active treatment of concentrations higher than $20 \mu\text{g/l}$ (**Figure 2-1**) would be the most beneficial option. This will allow for an active treatment, followed by 30 years or less of MNA, while remaining cost effective.

Table 2-1. Evaluation of Cost/Benefit of PCE Plume Treatment Options

Concentration ^a	Area requiring treatment	Volume requiring treatment ^b	Estimated Time for MNA ^c	Estimated Plume Expansion	ROM ^d Costs
59 µg/l (2006 conditions)	0	0 gallons	40 yr	300 ft	\$0.5M
20 µg/l	27,095 ft ²	1,770,022 gallons ^e	30 yr	0 ft	\$1-3M
10 µg/l	66,181 ft ²	5,495,258 gallons ^f	25 yr	0 ft	\$3-5M
1 µg/l (cleanup criteria)	145,395 ft ²	14,683,007 gallons ^g	0 yr	0 ft	\$7-10M

Notes: ^aConcentrations are assumed to be the maximum concentration within the plume. For example, the 20 µg/l concentration assumes that active treatment will reduce concentrations to 20 µg/l.

^b Thickness used to calculate volume was estimated using the data collected during the RI and based assumes a porosity of 30%.

^c Time was estimated using the BIOCHLOR Model, results of which are presented in Appendix C.

^d ROM = Rough Order of Magnitude and should not be used for budgeting purposes.

^e Average saturate thickness of 20 µg/l contour assumed to be 30 feet.

^f Average saturate thickness of 10 µg/l contour assumed to be 37 feet.

^g Average saturate thickness of 1 µg/l contour assumed to be 45 feet.

2.2 IRP SITE 6

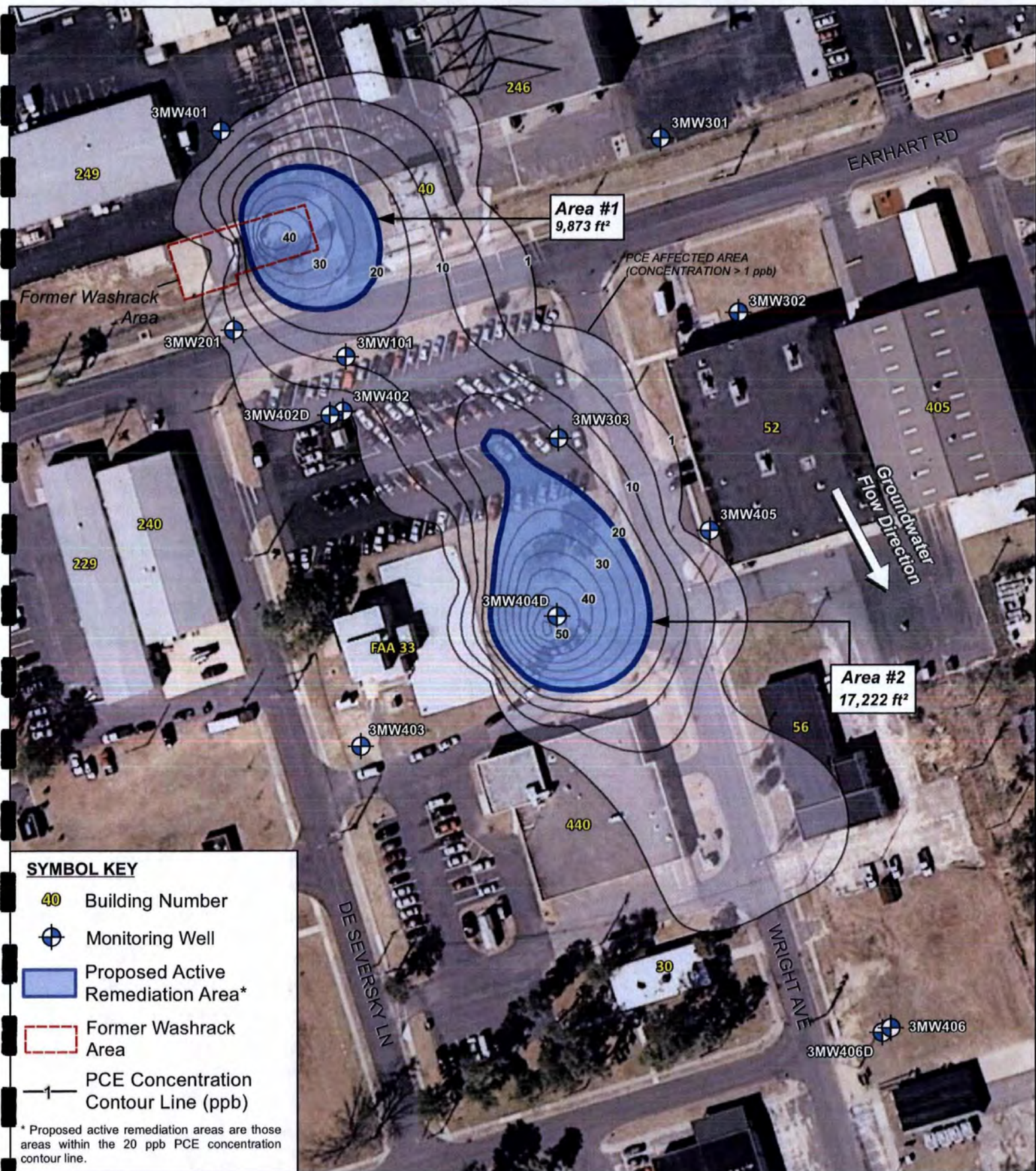
The total amount of contaminated soil at IRP Site 6 is 29 cubic yards (CY). Due to the small size of the impacted area, the RAOs for this site are focused on removing the contamination to concentrations below the NJDEP soil standards. Soil removal will be protective of human health and the environment and will prevent leaching of contaminants into the groundwater.

2.3 RAOs AND GRAS FOR IRP SITE 3 AND IRP SITE 6





The RAOs and GRAs for Sites 3 and 6 are presented in **Table 2-2**. The different types of GRAs are discussed in the following sections.

Table 2-2. Remedial Action Objectives and General Response Actions by Site

IRP Site 3		IRP Site 6	
Remedial Action Objectives			
<ul style="list-style-type: none">• Reduce the contaminant levels in groundwater to below the applicable GWQS;• Prevent exposure to contaminated groundwater that could be harmful to human health and the environment;• Prevent further migration of contaminated groundwater; and,• Achieve site closure in approximately 30 years by actively treating PCE areas greater than 20 µg/l.		<ul style="list-style-type: none">• Reduce the contaminant levels in soil to the NJDEP soil standards by removing impacted soil from the site;• Prevent exposure to contaminated soil that could be harmful to human health and the environment; and,• Prevent migration of contaminants from soil leaching to groundwater.	
General Response Actions			
<ul style="list-style-type: none">• No Action;• Institutional Controls;• Containment;• In-Situ Technologies; and,• Ex-Situ Technologies and Discharge.		<ul style="list-style-type: none">• No Action;• Institutional Controls; and,• Ex-Situ Technologies and Disposal.	



SYMBOL KEY

- 40 Building Number
-  Monitoring Well
-  Proposed Active Remediation Area*
-  Former Washrack Area
-  PCE Concentration Contour Line (ppb)

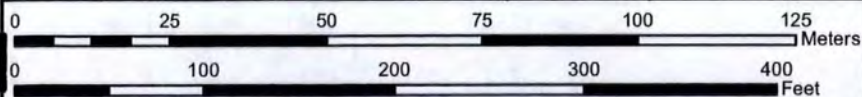
* Proposed active remediation areas are those areas within the 20 ppb PCE concentration contour line.

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177th Fighter Wing
Egg Harbor Township, NJ**



FIGURE 2-1 IRP Site 3 Areas Proposed for Active Remediation

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177th Fighter Wing, Egg Harbor Township, New Jersey



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2.3.1 No Action

No Action implies that no remedial action will be conducted. The "No Action" GRA does not involve any remedial action; therefore, groundwater and soil at IRP Sites 3 and 6, would be allowed to continue in their current states, and no future actions will be conducted to remove or remediate the contamination. No access restrictions will be put into place, and no deed restrictions are placed on the site. The NCP requires that "no action" be included among the general response actions evaluated in every FS, as detailed in 40 CFR 300.430(e)(6). The no action response will be evaluated for both IRP Sites 3 and 6 and provides a baseline for comparison to the other remedial response actions.

2.3.2 Institutional Controls

Institutional controls (ICs) are generally administrative and legal tools that help minimize the potential for human exposure to contamination without construction or physically changing the site. ICs are generally divided into four categories (government controls, proprietary controls, enforcement tools, and informational devices). ICs can be an effective means of eliminating possible pathways of exposure and restricting access to contaminated media and are usually required as a part of long-term remedial actions in accordance with the NJDEP. ICs do not reduce the toxicity, mobility, or volume of contamination, but are implemented to reduce the probability of physical contact with contaminated media while natural processes are occurring. ICs will be evaluated at IRP Site 3 in conjunction with, rather than in lieu of, other GRAs. ICs are not expected to be necessary for the short-term soil removal at IRP Site 6.

2.3.3 Containment

Containment technologies involve the construction of physical barriers to control or reduce the migration of contaminants into the surrounding environment. They could also be used to isolate contaminated groundwater and soils to reduce precipitation infiltration and groundwater flow into source materials causing additional dissolved contamination and potential increased exposure to COCs. Containment measures for contaminated groundwater and source soils typically include caps, vertical/horizontal barriers, and hydraulic barriers (extraction wells).

At IRP Site 3, containment technologies such as extraction wells would prevent the migration of the PCE plume. However, containment will not reduce concentrations within the impacted area and will not achieve the RAO for IRP Site 3 of actively treating PCE concentrations of greater than 20 µg/l. Therefore, containment technologies will not be evaluated for the groundwater at IRP Site 3. Containment technologies will also not be evaluated for IRP Site 6 because they will not achieve the RAO by removing the contaminated soil from the site.

2.3.4 In-Situ Technologies

In-situ technologies consist of natural processes or actions that treat contaminants in place utilizing methods to separate and remove contaminants or to degrade contaminants in place. In-situ technologies to separate and remove contaminants include soil flushing, in-situ thermal

treatment, air sparging, soil vapor extraction, and chemical oxidation. In-situ biological technologies involve the use of natural processes or the addition of microbes to degrade the contaminants or addition of nutrients to enhance natural biologic processes. In-situ technologies will be evaluated for the impacted groundwater at IRP Site 3 because they will allow the groundwater to be actively treated to PCE concentrations of 20 µg/l or less, thereby achieving the RAOs. At IRP Site 6, in-situ technologies will not be evaluated because they are not cost effective for such a small amount of soil and because they will not achieve the RAOs by removing the contaminated soil from the site.

2.3.5 Ex-Situ Technologies and Discharge/Disposal

Ex-situ technologies and discharge or disposal consists of actions that treat contaminants after removal from the subsurface. In groundwater, ex-situ technologies can involve physical or chemical processes such as air stripping, carbon adsorption, biological treatment, precipitation/co-precipitation, ion exchange, or reverse osmosis. When groundwater is treated ex-situ, it is generally discharged off site or injected back into the aquifer. Ex-situ treatment of contaminated soil includes methods to stabilize contaminants, separate and remove contaminants, or to degrade contaminants. Solidification, stabilization, soil washing, thermal treatment/destruction, chemical oxidation, and biodegradation in land treatment units or compost piles are some examples of ex-situ treatment.

At IRP Site 3, ex-situ technologies would be combined with groundwater removal (extraction wells) to prevent the migration of the PCE plume. As with containment technologies, extracting groundwater from the aquifer will not significantly reduce concentrations of PCE. The PCE that is adsorbed to the soil or “trapped” in disconnected pore spaces will remain in the aquifer and the RAO of reducing PCE to concentrations of greater than 20 µg/l will not be met. Therefore, ex-situ technologies will not be evaluated for the groundwater at IRP Site 3. Ex-situ technologies will be evaluated for IRP Site 6 because these options are cost effective, immediately successful, and easily implementable at sites with relatively small impacted areas.

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES TYPES AND PROCESS OPTIONS

In this section, potentially applicable technology types and process options are evaluated with respect to technical implementability. The term ‘technology types’ refers to general categories of technologies such as chemical treatment, biological treatment, and vertical barriers. The term ‘process options’ refers to the specific processes within each technology type. In this section, remedial technology types and process options are identified and screened per site and environmental media.

2.4.1 IRP Site 3 Groundwater

The following sections describe the remedial technology types and associated process options screened and evaluated for IRP Site 3. The No Action alternative is not discussed below but is retained for further evaluation as required by NCP.

2.4.1.1 Governmental Institutional Controls

The governmental institutional control process option evaluated for IRP Site 3 is the designation of the site as a Classification Exemption Area (CEA), as described below.

Classification Exemption Area

CEAs are established by the NJDEP with the intent to ensure that the uses of the impacted aquifer are restricted until standards are achieved. CEAs provide public notice that groundwater on the site exceeds applicable groundwater aquifer standards and restrict the use of groundwater within the impacted aquifer by prohibiting the installation of potable water wells. It further establishes that while groundwater contamination is present on the site, natural attenuation (degradation of contaminants) is occurring. Pursuant to the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, a CEA permit would be applied for and obtained prior to the implementation of a remedial action.

Evaluation: While CEAs would be effective in preventing exposures to impacted groundwater at IRP Site 3, they are not considered effective for reaching the RAOs. It is estimated that it will take 40 years or more for PCE concentrations to naturally attenuate. In addition, this process option will not prevent the migration of the plume. CEAs are readily implementable through the NJDEP and have minimal associated costs.

Summary: The implementation of CEAs alone will not achieve RAOs. However, they are required as a part of any groundwater remedial action that includes MNA. Therefore, they will be retained as a process option for incorporation into proposed alternative(s) that include an MNA component.

2.4.1.2 In-Situ Physical Processes/Treatment

The in-situ physical processes or treatment options evaluated for IRP Site 3 are MNA, air sparging/soil vapor extraction (AS/SVE), steam injection, and electrical resistance heating. These process options are described and evaluated below.

Monitored Natural Attenuation

Natural attenuation is a naturally occurring process that acts without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. This in-situ process typically includes biodegradation, dispersion, advection, and volatilization. As discussed in Section 1.8.1, the impacted aquifer at IRP Site 3 is an aerobic environment and is not conducive for reductive dechlorination processes. Based on the lack of daughter products observed, minimal, if any, biodegradation is naturally occurring. Therefore, MNA at IRP Site 3 will consist primarily of advection and dispersion processes. In order to monitor the attenuation of the groundwater plume, a network of monitoring wells would be installed. These wells would be initially monitored for PCE on a quarterly basis for two years, and then monitored annually or possibly biannually until RAOs are achieved.

Evaluation: At IRP Site 3, conditions in the aquifer are not favorable for intrinsic reductive dechlorination of PCE. Modeling of PCE in groundwater at the Site (see Section 1.8.1) suggests that concentrations of PCE will be reduced to the RAO of 1 µg/l in approximately 40 years and the plume will migrate approximately 300 feet from its current location. MNA could be readily implemented at IRP Site 3. It is a proven alternative that has been implemented at other federal facility sites where the groundwater has been contaminated. The capital costs associated with the MNA process option are relatively low and would only involve the installation of monitoring wells. While the monitoring is expected to continue for 40 years, the overall present value costs of this monitoring are relatively low since there is no system requiring maintenance.

Summary: While the MNA process option cannot achieve the RAOs alone in the short-term (i.e. less than 30 years), it can be used as a baseline to compare against other alternatives and it can be combined with other active remediation technologies to achieve RAOs. Therefore, this process option will be retained to be included as a baseline alternative and combined with active treatment process options as potential alternatives.

Air Sparging and Soil Vapor Extraction

AS/SVE is a dual process which injects air into the subsurface, causing contaminants to volatilize, where they are extracted as volatilized vapors from the unsaturated zone. As the injected air rises through the saturated zone, it tends to volatilize and remove adsorbed VOCs in soil as well as strip dissolved contaminants from groundwater. AS/SVE also oxygenates the groundwater, thereby enhancing the potential for biodegradation at sites with contaminants that degrade aerobically. To control subsurface airflow and prevent contaminated soil vapor from migrating to previously uncontaminated areas, vapor extraction wells induce air flow through the contaminated vadose zone soil. Contaminants sorbed onto soil particles will desorb from these phases to the vapor phase and be drawn to the extraction points. The exhaust gas may then be treated, if necessary, and discharged by permit.

AS/SVE is most effective at sites with homogeneous, high-permeability soil and unconfined aquifers and can be implemented to treat a specific zone or area of contamination. At IRP Site 3, this process option would be used to actively treat the areas with PCE concentrations of 20 µg/l or higher.

Evaluation: AS/SVE is an effective and commonly used technology for remediation of a saturated zone (groundwater and soil) contaminated with VOCs, including PCE. Likewise, the ability of AS/SVE to meet RAOs in a reasonable timeframe (less than 30 years) is dependent upon the nature and extent of contaminant source material. It is assumed that at IRP Site 3, AS/SVE would be used to reduce the PCE concentrations within the plume to approximately 20 µg/l. AS/SVE are considered to be easy to moderately difficult to implement at IRP Site 3, due to the aquifer depths and the potential presence of existing structures and other physical constraints that could inhibit component installation. The cost of implementing an AS/SVE

system, including installation of air lines, sparge points and equipment shelters, and operation and maintenance (O&M) is considered moderate.

Summary: AS/SVE will be retained as a potential technology option for IRP Site 3 because it has the potential to meet RAOs.

Steam Injection

Thermal treatments, such as steam injection, are typically used in saturated zone areas where high concentrations of VOCs are present and addresses those compounds that are not readily removed with conventional remedial techniques. Steam injection involves the introduction of steam into injection wells and the removal of mobilized groundwater, contaminants, and vapor from recovery wells. The applicability of steam injection to a particular site is determined by the permeability of the soil, the depth at which the contaminants reside, and the type and degree of heterogeneity, as well as the contaminant type. It is most effectively applied to sites containing high concentrations of VOCs and the permeability of the soil must be high enough to allow sufficient steam to be injected to heat the entire source zone. Shallow treatment areas are difficult to heat with steam, and collection of all the vapors generated may be challenging; an impermeable surface cover can help in this regard.

Evaluation: Steam injection requires significant amounts of equipment and energy resources, and costs are higher as a result. They are typically utilized at sites with gross contamination or where contaminants are hard to access with other technologies. In addition, the saturated thickness (~45 ft) and depths of portions of the PCE plume (~60 ft bgs) will impede the effectiveness of this technology. The cost of implementing, operating and maintaining thermal treatment at IRP Site 3 is high.

Summary: Due to the high relative cost, low concentrations of PCE, and potential difficulties associated with the saturated thickness of contamination, this technology will not be carried forward.

Electrical Resistance Heating

Electrical resistance heating (ERH) uses an electrical current to heat less permeable soils such as clays and fine-grained sediments so that water and contaminants trapped in these relatively conductive regions are vaporized and ready for vacuum extraction. Electrodes are placed directly into the less permeable soil matrix and activated so that electrical current passes through the soil, creating a resistance which then heats the soil. The heat dries out the soil causing the soil to become more permeable allowing the use of SVE to remove the contaminants. The heat created by electrical resistance heating also forces trapped liquids to vaporize and move to the steam phase for removal by SVE. ERH is most effective at sites with less permeable soils, such as clays.

Evaluation: The soils at IRP Site 3 are sandy and have a relatively high permeability on the order of 10^{-3} cm/sec. Therefore, it is unlikely that ERH will be effective at IRP Site 3 and will not reach the RAOs. As with steam injection, ERH requires significant amounts of energy and costs are higher as a result.

Summary: Because ERH is less effective in sandy soils and has a relatively high cost, this technology will not be carried forward and will not achieve RAOs.

2.4.1.3 In-Situ Biological Treatment

The in-situ biological treatment process options evaluated for IRP Site 3 include enhanced anaerobic bioremediation, enhanced cometabolic aerobic bioremediation, and phytoremediation. These process options are described and evaluated below.

Enhanced Anaerobic Bioremediation

Enhanced in-situ anaerobic bioremediation involves the delivery of an organic substrate into the subsurface for the purpose of stimulating microbial growth and development, creating an anaerobic groundwater treatment zone, and generating hydrogen through fermentation reactions. This creates conditions conducive to anaerobic biodegradation of chlorinated solvents dissolved in groundwater. In some cases, organisms may need to be added, but only if the natural microbial population is incapable of performing the required transformations. Advantages of enhanced anaerobic bioremediation include complete mineralization of the contaminants in-situ with little impact on infrastructure and relatively low cost compared to more active engineered remedial systems.

Evaluation: Anaerobic bioremediation is not effective unless the contaminants are anaerobically biodegradable, strongly reducing conditions can be generated and maintained, a microbial community capable of driving the process is present or can be introduced and maintained, and an organic substrate can be successfully distributed in the subsurface. Conditions at IRP Site 3 are aerobic and not conducive to anaerobic processes.

Summary: This technology will not be carried forward for development of alternatives because conditions within the PCE plume at IRP Site 3 are not conducive to anaerobic processes.

Enhanced Cometabolic Aerobic Bioremediation

Bioremediation of PCE in an aerobic aquifer occurs through biostimulation and bioaugmentation, resulting in cometabolic processes in which an enzyme produced during microbial metabolism of another compound degrades the PCE. Aerobic cometabolic bioremediation would involve the injection of a carbon source and microorganisms into the contaminant plume to establish or enhance biological activity and contaminant degradation. Typically, the microorganisms are delivered as a liquid containing millions of microbes in a nutrient solution. Initial biodegradation of PCE would be through co-metabolic processes. The PCE would be degraded through the metabolic processes of the introduced microorganisms.

Subsequent PCE daughter decomposition would occur through the natural respiration of the introduced microorganisms under the aerobic aquifer conditions. Injectant products as CL-Out[®] has been used for the bioremediation of chlorinated organic compounds under aerobic aquifer conditions. CL-Out[®] is most effective when pH is between 6.5 and 7.5, temperature is 65-75° Fahrenheit, salinity is less than 5%, and DO is between 1 and 8 mg/l.

Evaluation: At IRP Site 3, conditions in the aquifer are aerobic and highly oxidizing. However, the pH in the aquifer is acidic and typically less than 5.5. Therefore, conditions are not favorable for the survival of microbes and this cometabolic aerobic bioremediation will not be further evaluated.

Summary: Aerobic bioremediation will not be considered for further evaluation because injected microbes will not tolerate the low pH values in the current plume environment.

Phytoremediation

In-situ phytoremediation is a process which uses plants to address shallow groundwater contamination by removing, transferring, stabilizing, or destroying contaminants. The mechanisms of phytoremediation include: enhanced rhizosphere biodegradation; phytoextraction, which is the uptake of contaminants by plant roots and the translocation or accumulation of contaminants into plant shoots and leaves; phytodegradation, the metabolism of contaminants within plant tissues; and phytostabilization, the production of chemical compounds by plants to immobilize contaminants at the interface of roots and soil. Depending on the types of trees, climate, and season, trees can act as organic pumps when their roots reach the water table and establish a dense root mass that takes up large quantities of water. The effectiveness of phytoremediation is limited by the root structure and is not effective in deep contamination plumes.

Evaluation: Since contamination at IRP Site 3 extends to a depth of up to 60 feet, phytoremediation is not considered a viable technology.

Summary: Phytoremediation is not retained for further evaluation in the development of remedial alternatives because it would not be effective at the depth of contamination found at IRP Site 3 and therefore, will not achieve RAOs.

2.4.1.4 In-Situ Chemical Treatment

The in-situ chemical treatment process options evaluated for IRP Site 3 are permeable reactive barrier (PRB) and chemical oxidation. These two process options are described and evaluated below.

Permeable Reactive Barrier

A PRB is defined as an in-situ method for remediating contaminated groundwater that combines a passive chemical or biological treatment zone with subsurface fluid flow management. The

PRB is not a barrier to the groundwater, but it is a barrier to the contaminant. Treatment media would include zero-valent iron mixed with sand, which will chemically reduce contaminants and prevent the plume from migrating downgradient.

Evaluation: PRBs have been demonstrated to be reliable and effective in preventing the migration of contaminant plumes. This alternative could be protective of human health and the environment by passively treating the plume and preventing plume migration.

Summary: This process option will be carried forward because it would be effective in preventing plume migration, and could allow for site closure within 30 years.

Chemical Oxidation

In-situ chemical oxidation (ISCO) involves injection of an oxidant, such as a permanganate solution, into injection wells drilled into the PCE-contaminated groundwater to reduce contaminant concentrations through the oxidation of VOCs. Some of the injected oxidant is consumed by TOC and therefore, low TOC environments like IRP Site 3 allow more of the permanganate to oxidize VOCs. Success of ISCO is based on the ability to distribute the oxidant throughout the formation, which is typically easier in coarse-grained soils.

Evaluation: ISCO has been shown to be effective for treating PCE in groundwater and has been demonstrated to be reliable in sandy soils. If injected into areas with PCE concentrations greater than 20 µg/l, it is anticipated that this process option would reduce these concentrations to 20 µg/l or less. This process option could be readily implementable at IRP Site 3. Equipment and subcontractors providing these services are readily available. The cost for this process option is moderate.

Summary: ISCO will be retained for further consideration because it could be effective in reducing concentrations of PCE and preventing plume migration.

2.4.1.5 Summary of Retained Technology Types and Process Options for Site 3

As shown in **Table 2-3**, the most viable remedial technology types for groundwater at IRP Site 3 are identified as no action, institutional controls, and in-situ physical, biological, chemical treatments. Each process option presented in **Table 2-3** was screened for applicability at the site and either retained or not retained for further evaluation with regard to effectiveness, implementability, and cost. As a result of this screening process, the process options carried forward for development of alternatives are as follows:

- No Action;
- Classification Exemption Area (Institutional Controls);
- Monitored Natural Attenuation;
- Air Sparging/Soil Vapor Extraction;
- Chemical Oxidation; and,
- Permeable Reactive Barrier.

2.4.2 IRP Site 6 Soil

The total amount of contaminated soil at IRP Site 6 is 29 CY. Due to the small size of the area requiring remediation, a presumptive remedy is proposed for IRP Site 6. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and scientific and engineering evaluation of performance data on technology implementation. Since a presumptive remedy is a technology that generally will be the most appropriate remedy for a specified type of site, the presumptive remedy approach will accelerate site-specific analysis of remedies by focusing the FS efforts. Therefore, the process of remedial technology and process option identification and evaluation will not be performed and only the presumptive remedy and no action will be carried forward for development into alternatives.

In accordance with the NJDEP Site Remediation Program, discrete area discharges (300 CYs or less of contaminated soil) are areas of contamination that can readily be remediated by excavation and off-site disposal using routinely available construction equipment and conventional techniques. Therefore, the following process options will be developed into alternatives for IRP Site 6:

- No Action; and,
- Excavation and Disposal.

Table 2-3. Screening of Process Option Technologies for IRP Site 3

Screening of Potential Remedial Technologies and Process Options				Evaluation of Process Options					
Media	General Response Action	Remedial Technology Type	Potentially Applicable at IRP Site 3?	Process Option	Effectiveness		Implementability (Easy, Moderate, Difficult)	Cost ^a (Low, Medium, High)	Retained for Evaluation and Incorporation into Alternative?
					Site closure within 30 yrs?	Prevent plume migration?			
Ground-water	No Action	None	Yes	No Action	No	No	Easy	Low	Yes, as required by NCP.
	Institutional Controls	Governmental Institutional Controls	Yes	Classification Exemption Area	No	No	Easy	Low	Yes, required as a part of long-term monitoring.
	Containment	Physical/Hydraulic Barriers	No – will not reduce PCE concentrations	NA	NA ^b	NA	NA	NA	No
	In-Situ Technologies	Physical Processes/Treatment	Yes	Air Sparging/Soil Vapor Extraction	Yes	Yes	Difficult	Moderate	Yes, has the potential to achieve RAOs.
				Steam Injection	Yes	Yes	Difficult	High	No, high cost and uncertain effectiveness.
				Electrical Resistance Heating	Yes	Yes	Difficult	High	No, less effective in sandy soils and high cost.
				Monitored Natural Attenuation	No	No	Easy	Low	Yes, retained as a baseline comparison and for combination with active treatments.
		Biological Treatment	Yes	Enhanced Anaerobic Bioremediation	No	No	Moderate	Moderate	No, not effective in aerobic aquifer.
				Enhanced Aerobic Cometabolic Bioremediation	Yes	Yes	Moderate-Difficult	Moderate	No, microbes will not survive in low pH environment.
				Phytoremediation	No	No	Moderate-Difficult	Low-Moderate	No, ineffective at deep depths.
		Chemical Treatment	Yes	Permeable Reactive Barrier	Yes	Yes	Moderate	High	Yes, has the potential to achieve RAOs.
				Chemical Oxidation	Yes	Yes	Moderate	Moderate	Yes, has the potential to achieve RAOs.
	Ex-Situ Technologies and Disposal	Physical/Biological/Chemical Treatments	No – will not reduce PCE concentrations	NA	NA	NA	NA	NA	No

Notes: ^a Cost assumptions based on the Federal Remedial Technologies Roundtable Screening Matrix (2007, FRTR).

^b NA = Not Applicable

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3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section presents the development and description of remedial alternatives assembled from combinations of technologies and associated process options carried forward from the technology screening. The approach to development and screening, a description of each alternative, and the screening results are provided below.

3.1 DEVELOPMENT OF ALTERNATIVES

The CERCLA remedial alternative selection process (i.e., the FS, PP, and ROD) is used to identify and plan the implementation of CERCLA remedial actions that eliminate, reduce, or control risks to human health and the environment [40 CFR 300]. Criteria for identifying possible applicable technologies to achieve these goals are provided in USEPA guidance (USEPA 1988) and in the NCP.

The NCP defines the following preferences in developing remedial action alternatives:

- Use of treatment to address the principal threats posed by a site, wherever practical.
- Use of engineering controls (e.g., containment) for waste that poses a relatively low, long-term threat and for which treatment is not practical.
- Implementation of a combination of actions, as appropriate, to achieve protection of human health and the environment.
- Use of institutional controls (e.g., CEAs) to supplement engineering controls for short- and long-term management to prevent or limit exposures.
- Selection of an innovative technology when the technology offers the potential for comparable or better treatment performance or implementability, fewer adverse impacts than other technologies, or lower costs than demonstrated technologies for similar levels of performance.
- Restoration of environmental media, such as groundwater, to their beneficial uses whenever practical and within a reasonable time frame. When restoration of groundwater to beneficial uses is not practical, USEPA expects to prevent further migration of the contaminant plume, prevent human and environmental exposures to contaminated groundwater, and evaluate further risk reduction.

The purpose of the range of remedial alternatives is to present the decision-makers with several technical and economic options to achieve the RAOs. Regulatory preferences and considerations were also a factor in development of the remedial alternatives.

3.1.1 Development of Alternatives for IRP Site 3 Groundwater

The process options carried forward from the screening of technologies and process options were combined to form preliminary remedial alternatives. The remedial action alternatives developed for IRP Site 3 to meet the RAOs are as follows:

- Alternative 1: No Action;

- Alternative 2: MNA;
- Alternative 3: AS/SVE and MNA;
- Alternative 4: ISCO and MNA; and
- Alternative 5: PRB and MNA.

The process options carried forward from Section 2 and the alternatives developed using each process option are shown in **Table 3-1**.

Table 3-1. Development of Remedial Action Alternatives for IRP Site 3 Groundwater

General Response Actions	Remedial Technology Types	Process Options	Preliminary Alternatives for Screening				
			No Action	MNA	AS/SVE and MNA	ISCO and MNA	PRB and MNA
No Action	None	No Action	✓				
Institutional Controls	Governmental Institutional	Classification Exemption		✓	✓	✓	✓
In-Situ Treatment	Physical Processes/Treatment	Air Sparging/Soil Vapor Extraction			✓		
		Monitored Natural Attenuation		✓	✓	✓	✓
	Chemical Treatment	Chemical Oxidation				✓	
		Permeable Reactive Barrier					✓

3.1.2 Development of Alternatives for IRP Site 6 Soil

Process options were not evaluated for IRP Site 6 because of the proposed presumptive remedy for the site. Therefore, two alternatives will be carried forward for further evaluation:

- Alternative 1: No Action
- Alternative 2: Excavation and Disposal

3.2 SCREENING OF ALTERNATIVES

The alternatives presented in Section 3.1 have been developed according to the NCP (40 CFR 300.430 [e]) and are intended to meet the RAOs. Each alternative is presented in the following paragraphs in sufficient detail to allow effective screening against the short- and long-term aspects of the three criteria listed below.

Effectiveness: Includes how each alternative is effective in protecting human health and the environment and reducing toxicity, mobility, and the volume of contaminant.

Implementability: Includes the technical and administrative feasibility of constructing, operating, and maintaining the remedy.

Cost: Includes general capital and O&M cost analysis sufficient for comparison against each other, but not with as much accuracy as is needed in the detailed analysis (+50% to -30%). Cost assumptions were made on general engineering judgments to evaluate whether costs are high, medium, or low relative to other options and based on information provided by the Federal Remedial Technologies Roundtable (FRTR) (FRTR, 2007).

3.2.1 Screening of Alternatives for IRP Site 3: Groundwater

3.2.1.1 Alternative 1: No Action

3.2.1.1.1 Description

A “No Action Alternative” provides a baseline for evaluating other removal action alternatives and is compliant with USEPA guidance (USEPA, 1988). Under this alternative, no remedial action will be taken, and any identified contaminants are left “as is” without the implementation of any containment, removal, treatment, or other protective measures. This alternative does not provide for site monitoring and does not provide for any active or passive ICs to reduce the potential for exposure.

3.2.1.1.2 Evaluation

Effectiveness: Contaminants present will naturally attenuate at some rate under this alternative, thereby providing some level of protection to human health and the environment and reduce concentrations of PCE. While it is likely that COC concentrations will be reduced in the long-term; however, without monitoring this alternative will not achieve the RAOs.

Implementability: This alternative is easy to implement since no actions are required.

Cost: There are no associated costs with this alternative.

Summary: This alternative will be carried forward in accordance with the NCP to provide a basis of comparison during the detailed analysis of alternatives.

3.2.1.2 Alternative 2: Monitored Natural Attenuation

3.2.1.2.1 Description

MNA relies on the subsurface attenuation processes to achieve site-specific RAOs as compared to other more active remedial methods. Natural attenuation processes active in the MNA approach include physical, chemical, and/or biological processes that act without human intervention to reduce mass, toxicity, volume, mobility, or concentration of contaminants. At IRP Site 3, PCE naturally attenuates through advection/dispersion processes.

In order to monitor the progress of MNA and ultimately obtain site closure, a groundwater monitoring program would be needed. Several monitoring wells are currently positioned to

monitor the natural attenuation of site contaminants. It may be necessary to install additional wells to adequately monitor natural attenuation parameters and plume characteristics. Monitoring well locations would be decided based on discussions with project stakeholders. The monitoring program would be conducted quarterly for two years and then annually or possibly bi-annually until levels of COCs are reduced to concentrations below cleanup levels. It is estimated that it will take approximately 40 years for the PCE contaminants to naturally attenuate to below the cleanup criteria.

3.2.1.2.2 Evaluation

Effectiveness: Results from the RI (ANG, 2011) indicate that PCE daughter products are not present at concentrations exceeding the screening criteria, suggesting that degradation of PCE is not occurring. Modeling efforts indicate that toxicity, mobility and volume of contaminants in groundwater will be permanently reduced over the long-term due to natural attenuation physical processes. However, the estimated timeframe for the contaminants to reduce to concentrations below cleanup criteria is 40 years, which will not meet RAOs.

Implementability: Implementation of this alternative is relatively easy. All services required (well installation, environmental sampling activities, laboratory analysis, environmental reporting) are readily available. In accordance with the NJDEP groundwater CEA rules, the establishment of ICs is required to limit access to impacted groundwater during long-term monitoring activities.

Cost: The initial cost of this alternative is relatively inexpensive as no active remediation will be conducted. However, the duration of groundwater monitoring associated with this alternative is dependent on the long-term monitoring and reporting requirements and accrued cost over the life of the project. Establishing ICs has both an administrative and technical component/cost due to development and reporting requirements within the NJDEP regulatory framework. Costs associated with this alternative will include remedial action permit fees, installation of monitoring wells, labor and equipment for groundwater sampling activities, laboratory services, and environmental reporting over the life of the plume.

Summary: Implementation of this alternative will not reduce toxicity, mobility, or volume of contaminants in groundwater in the short-term. However, it will provide a means to evaluate other alternatives and to monitor the natural physical processes which will ultimately reduce contaminant concentrations to cleanup levels. Therefore, MNA will be carried forward for detailed analysis.

3.2.1.3 Alternative 3: Air Sparging/Soil Vapor Extraction and MNA

3.2.1.3.1 Description

The sparging portion of the AS/SVE process involves the injection of air through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column,

This is not necessary for GERCIA project. After to conduct permit equivalent, do not have to pay permit fees. Remedial Design - Comment #1

EPA also require implementation of ICs general comment #1

creating an underground stripper that removes volatile and semivolatile organic contaminants by volatilization. The injected air helps to flush the contaminants into the unsaturated zone. The SVE portion of the process removes the generated vapor-phase contamination from the vadose zone. Because the two areas with PCE >20 µg/l are different in size and depth of contamination, a separate AS/SVE system would be installed in each area. Each system would involve the installation of a temporary building and control panels, compressors, blowers, etc.; AS and SVE wells within the treatment area; and, associated piping. The piping would be installed underground and backfilled to minimize disruption to Base operations. The systems would operate on a "pulsing" schedule to minimize the creation of preferential pathways.

Once the PCE has volatilized and the vapors have been removed from the soil, the air stream must be treated prior to discharging into the atmosphere, which would be accomplished using granular activated carbon (GAC).

It is assumed that the AS/SVE systems would remain in operation approximately three years as volatilization would be the only treatment process occurring in the aquifer. After PCE concentrations have reached 20 µg/l, the AS/SVE systems would be shut down. The MNA processes would then become the final remedy. The AS/SVE systems would be decommissioned, the wells would be abandoned, and all components would be removed from IRP Site 3.

It is anticipated that PCE concentrations will reach 1 µg/l within approximately 30 years of completion of AS/SVE activities. Upon an NFA determination, the monitoring wells at the site would be permanently abandoned.

Prior to any remediation at IRP Site 3, a CEA must be established in accordance with the New Jersey GWQS, because groundwater at the Site exceeds the applicable standards. In addition, a Remedial Action Permit (RAP) would be obtained through the NJDEP and renewed until the site reaches closure.

3.2.1.3.2 Evaluation

Effectiveness: AS/SVE is a proven, reliable strategy for remediating groundwater contaminated with VOCs. The three most significant factors affecting performance are the air distribution in the target treatment zone, the distribution of contaminants relative to the air distribution, and the contaminant characteristics. It is assumed that the sandy nature of the soils at IRP Site 3 will allow the injected air to easily travel to the unsaturated zone, stripping and volatilizing PCE along the path.

AS/SVE technology does not introduce any contaminants or chemicals into the subsurface. Therefore, there is no increase in risks anticipated for potential receptors with implementation of enhanced aerobic bioremediation.

It should be noted that AS/SVE typically has a twofold effect. The injected air physically strips or volatilizes the contaminant as well as enhances aerobic bioremediation processes. An AS/SVE system at IRP Site 3 would not benefit from this secondary biological process. The effectiveness of this alternative is considered moderate due to the amount of time the active system will take to remediate PCE concentrations to 20 µg/l.

Implementability: The implementability of this alternative is considered difficult. Subsurface utilities will cause difficulties when trenching the piping and/or installing the AS/SVE wells. In addition, power requirements for AS/SVE systems are significant and new electrical and phone lines would be installed to run the system. Further, an air emission permit would be required for treated vapors.

All services required (environmental drilling/injection activities, environmental sampling activities, laboratory analysis, environmental reporting) are readily available. In accordance with the NJDEP groundwater CEA rules, the establishment of ICs is required to limit access to impacted groundwater during long-term monitoring activities.

— EPA also requires ICs

Cost: The capital costs associated with the AS/SVE system will be moderate and will include the construction of multiple AS/SVE systems. The presence of underground utilities could make implementation of this alternative difficult, and likely increase the capital cost. As with any fixed system, the AS/SVE systems will incur additional costs for O&M, such as utility usage and repairs or replacement costs. Due to the length of required 24/7 operation time, O&M costs are considered high.

Summary: This alternative will be carried forward for detailed analysis because it may achieve the RAOs by reducing concentrations of PCE to 20 µg/l or less and preventing plume migration. Soils at the site are ideal for volatilization of PCE through AS/SVE. While distribution is always an uncertainty in in-situ remedies, it is possible that AS/SVE systems could achieve RAOs. A pilot test is needed to evaluate the effectiveness further. The relative capital costs of this alternative are moderate and the O&M costs are high.

3.2.1.4 *Alternative 4 – In-Situ Chemical Oxidation with MNA*

3.2.1.4.1 *Description*

At IRP Site 3, injection points would be installed within the areas with PCE concentrations of 20 µg/l or more in locations sufficient to screen the saturated thickness of the target areas. Additional monitoring wells would also be installed to monitor the performance of ISCO injections. A permanganate solution was selected for evaluation and costing purposes because of its long-term persistence in the subsurface which allows for secondary transport of oxidant into smaller pore spaces.

For screening purposes, it is assumed that two injections would be required to treat the target areas and would be conducted approximately six months apart. It is assumed that the second

ISCO injection event would require approximately 50% of the level of effort as the first ISCO event. Upon completion of each event, performance monitoring would be conducted to monitor post-remedial effectiveness of the PCE plume.

Once it has been established that no additional injections are required and the injection remedy itself is considered complete, a MNA program would begin. The injection wells would be abandoned at the completion of the treatment period, which is anticipated to be approximately 5 months. ~~MNA monitoring would begin as required by the NJDEP.~~ Once MNA parameters have been established and indicate that MNA is effective at the site, a long-term monitoring program would commence ~~in accordance with CEA/NJDEP requirements~~ until levels of COCs are reduced to concentrations below cleanup levels.

3.2.1.4.2 Evaluation

Effectiveness: This alternative will protect human health and the environment through destruction of COCs to reduce COC concentrations below the RAO of 20 µg/l in a relatively short timeframe. ISCO is a proven technology and success at IRP Site 3 through this technology is considered relatively high due to the high permeability of the soil and persistence of the selected oxidant.

Implementability: ISCO would be implementable at the Site as access to the treatment area is relatively available. All services required (environmental drilling/injection activities, environmental sampling activities, laboratory analysis, environmental reporting) are readily available. In accordance with the NJDEP ground water CEA rules, the establishment of ICs is required to limit access to impacted groundwater during long-term monitoring activities.

Cost: The initial cost of this alternative is moderate because of the capital costs associated with active remediation and the long-term groundwater monitoring costs. Additional costs for this alternative will include required permitting, labor and equipment for groundwater sampling activities, laboratory services, and environmental reporting over the life of the plume.

Summary: This alternative will satisfy the RAOs for IRP Site 3. Initially, this alternative would provide active treatment across the areas of higher PCE concentrations, followed by MNA of the entire plume. This alternative is considered to be effective in remediating the constituents present at the site and is considered to be cost effective. As such, this alternative will be carried forward for detailed analysis.

3.2.1.5 Alternative 5 – Permeable Reactive Barrier and MNA

3.2.1.5.1 Description

This alternative would include the installation of multiple PRBs within the PCE-impacted area. Treatment media would include 100% zero-valent iron in a biodegradable guar solution, which will chemically reduce contaminants and is primarily employed to prevent the plume from

delete

Also
EPA
would
require
implementation
of ICs.

2 explain in
parentheses
regarding guar

migrating further down-gradient. Since source PCE areas are reported at the site, it is estimated that a minimum of four PRBs will be installed under this alternative to ensure that the entire plume would be treated. In each source area, one PRB would be installed at the downgradient edge of the area and a second would be installed through the middle of each area. Each PRB would be installed as a permanent unit. The configuration of each PRB will be a continuous 3-inch wall in which the treatment slurry is injected. Each 3-inch PRB wall will be constructed perpendicular to and intersecting the groundwater plume.

In order to monitor the plume and the effectiveness of the PRBs, a series of groundwater monitoring well will be installed immediately down-gradient of each PRB. Groundwater monitoring wells would also be installed down-gradient of the final PRB to ensure that contaminant concentrations remain below cleanup criteria. Groundwater monitoring activities would occur in accordance with the NJDEP requirements to obtain site closure. It is estimated that the higher PCE concentration areas will slowly be released/dissolved into the groundwater plume for treatment via the PRBs. Installation of multiple PRBs is a passive remedial alternative that is anticipated to reduce the long-term monitoring program from that of MNA alone.

3.2.1.5.2 Evaluation

Effectiveness: This alternative would protect human health and the environment by passively treating the plume. Toxicity, mobility, and volume of PCE would be decreased in the long-term through treatment with zero-valent iron.

Implementability: Labor and equipment to construct the PRBs are readily available and installation could be completed within a short time (< six months). However, coordination with Base engineering would be necessary prior to implementation of this alternative.

Cost: The initial cost of this alternative is high as multiple PRBs would need to be installed. Moderate duration of groundwater monitoring associated with this alternative will ultimately result in accrued cost over the life of the project but would be less than MNA alone. These costs will include installation of additional monitoring wells, labor and equipment for groundwater sampling activities, laboratory services, and environmental reporting over the life of the plume.

Summary: This alternative would require implementation across the areas of higher PCE concentrations to achieve the RAOs within a shorter timeframe than that of MNA alone. While this alternative could be effective in remediating the PCE at the site, there is uncertainty of the timeframe of this remediation due to the number of pore flushings required to sufficiently reduce PCE concentrations. In addition, the capital costs associated with the installation of multiple PRBs is high and not considered cost effective for relatively low concentrations of PCE. Based on this information, this alternative will not be carried forward for detailed analysis.

3.2.2 Screening of Alternatives for IRP Site 6 Soil

3.2.2.1 Alternative 1 – No Action

3.2.2.1.1 Description

A “No Action Alternative” provides a baseline for evaluating other removal action alternatives and is compliant with USEPA guidance (USEPA, 1988). Under this alternative, no remedial action will be taken, and any identified contaminants are left “as is” without the implementation of any containment, removal, treatment, or other protective measures. This alternative does not provide for site monitoring and does not provide for any active or passive ICs to reduce the potential for exposure.

3.2.2.1.2 Evaluation

Effectiveness: PAHs will naturally attenuate at some rate under this alternative, thereby providing some level of protection to human health and the environment and reducing concentrations of PAHs. However, long-term monitoring would not be conducted and verification of attenuation would not be documented. It should be noted that lead will not naturally attenuate under this alternative.

Implementability: This alternative is easy to implement as no actions are required.

Cost: There are no associated costs with this alternative.

Summary: This alternative will be carried forward in accordance with the NCP to provide a basis of comparison during the detailed analysis of alternatives.

3.2.2.2 Alternative 2 – Excavation and Disposal

3.2.2.2.1 Description

Excavation and offsite disposal involves excavating PAH and lead impacted soils in the areas identified as requiring removal. Soils requiring remediation would be excavated using traditional methods (small backhoe or similar) to an approximate depth of 6 inches. Excavated soils would be characterized and transported to an appropriate, permitted off-site disposal facility as non-hazardous waste. Confirmatory sampling of excavation extents may be required to confirm that the contamination has been removed to concentrations below the regulatory cleanup criteria. This alternative could be completed in less than one month.

3.2.2.2.2 Evaluation

Effectiveness: This alternative will protect human health and the environment by removal of impacted soil from the Site for offsite disposal. This alternative is highly effective and can be verified through confirmatory soil sampling of the excavation extents. It is estimated that the soil can be removed and application can be made for site closure within one year.

Implementability: This alternative is easily implementable as all services required (environmental construction/excavation, environmental sampling activities, laboratory analysis, environmental reporting) are readily available and the site currently exists as undeveloped land.

Cost: The capital costs of this alternative are low due to the small amount of soil requiring remediation. Additional costs may be required for confirmatory soil sampling of excavation extents. Long term monitoring would not be required for this alternative and O&M costs would be low.

Summary: The excavation and disposal alternative removes the contaminated soil from the site for offsite disposal within a one month timeframe. Therefore, this alternative will be carried forward for detailed analysis.

3.3 SUMMARY OF DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section presents a summary of the development and screening of alternatives for IRP Site 3 and IRP Site 6.

3.3.1 IRP Site 3

Table 3-2 summarizes the alternatives carried forward for detailed analysis for IRP Site 3 and provides the rationale for those alternatives not retained. As shown, the alternatives retained for detailed analysis for IRP Site 3 are No Action, MNA, AS/SVE and MNA, and ISCO and MNA.

Table 3-2. Screening of Alternatives Summary for IRP Site 3 Groundwater

Alternative	Effectiveness ^a	Implementability ^b	Cost ^c	Retained for Detailed Analysis?
1. No Action	Low	Easy	Capital: \$ O&M: \$	Yes – as required by NCP.
2. MNA	Low-Moderate	Easy	Capital: \$ O&M: \$	Yes – as a baseline comparison for other alternatives.
3. AS/SVE with MNA	Moderate-High	Difficult	Capital: \$\$ O&M: \$\$\$	Yes – Soil at site is ideal for AS/SVE and it could prove to be effective
4. ISCO with MNA	High	Moderate	Capital: \$\$ O&M: \$\$	Yes – Soil at site is ideal for injection and effectiveness is high due to the persistence of the oxidant
5. PRB with MNA	Moderate	Moderate	Capital: \$\$\$ O&M: \$	No – not cost effective at IRP Site 3.

Notes:

^a Effectiveness evaluated on a low, moderate, and high scale.

^b Implementability evaluated on an easy, moderate, and difficult scale.

^c Cost evaluated on a low cost (\$), moderate cost (\$\$), and high cost (\$\$\$) scale.

3.3.2 IRP Site 6

Table 3-3 summarizes the alternatives carried forward for detailed analysis and provides rationale for those alternatives not retained for IRP Site 6. As shown, the alternatives retained for detailed analysis are No Action and Excavation and Disposal.

Table 3-3. Screening of Alternatives Summary for IRP Site 6 Soil

Alternative	Effectiveness ^a	Implementability ^b	Cost ^c	Retained for Detailed Analysis?
1. No Action	Low	Easy	Capital: \$ O&M: \$	Yes – as required by NCP.
2. Excavation and Disposal	High	Easy	Capital: \$ O&M: \$	Yes –Effective, implementable, low cost alternative that can be accomplished within one month. Future land use would not be restricted.

Notes:

^a Effectiveness evaluated on a low, moderate, and high scale.

^b Implementability evaluated on an easy, moderate, and difficult scale.

^c Cost evaluated on a low cost (\$), moderate cost (\$\$), and high cost (\$\$\$) scale.

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4.0 DETAILED ANALYSIS OF ALTERNATIVES

In this section of the FS, the retained alternatives are developed in more detail and evaluated against evaluation criteria as outlined by the NCP. This evaluation includes a comparative analysis of the relative performance of each alternative to the nine required assessment criteria.

4.1 ASSESSMENT CRITERIA

The NCP (Section 300.430) requires that the alternatives be compared with one another using nine evaluation criteria. The purpose of the comparison is to identify the relative advantages and disadvantages of each alternative. These nine criteria are divided into subcategories: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria, as follows:

Threshold Criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

Modifying Criteria:

- State Acceptance
- Community Acceptance

The three criteria categories are based upon the role of each criterion during the evaluation and remedy selection process. The two Threshold Criteria relate directly to statutory requirements that must be satisfied by a selected alternative. The five Primary Balancing Criteria represent the primary technical, cost, institutional, and risk factors that form the basis of the evaluation. The two Modifying Criteria are typically evaluated following the receipt of state agency and public comments on the PP and will not be evaluated as a part of this FS.

4.1.1 Threshold Criteria

4.1.1.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment is one of two threshold requirements that each alternative must meet in order to be eligible for selection as a remedy (the other being compliance with ARARs). This criterion evaluates how the alternative will reduce the risk from potential exposure pathways and considers any unacceptable risks potentially posed in the short-term.

short-term effectiveness?

4.1.1.2 Compliance with ARARs

Compliance with ARARs is the second threshold requirement that each alternative must meet in order to be eligible for selection as a remedy. Alternatives are assessed to determine whether they meet ARARs or facility regulations and/or procedures. ARARs specific to the site are discussed in Section 1.10.

4.1.2 Primary Balancing Criteria

4.1.2.1 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk associated with untreated media or treatment of residuals remaining once remedial action activities are complete and objectives have been met. In addition, the adequacy and reliability of controls, such as containment systems and institutional controls, necessary to manage untreated media or treatment residuals and wastes are also considered.

4.1.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment assesses the degree to which the alternative employs treatment as the primary element that permanently and significantly reduces toxicity, mobility, or volume of contaminants. Factors to be considered include: the treatment/recycling process specific to site contaminants; the volume of material the alternative will treat; the degree of expected reduction in toxicity, mobility, or volume of contamination; the degree to which the treatment is irreversible; and, the type and quantity of residuals remaining following treatment.

4.1.2.3 Short-Term Effectiveness

Evaluation of short-term effectiveness determines whether alternatives are effective with relation to short-term risks that might be posed to the community during implementation of the alternative or until response objectives are met. Short-term risks include potential impacts to on-site workers and the environment during removal action activities and the effectiveness and reliability of protective and/or mitigative measures. When determining which alternative is more effective in the short-term, risks (to the community, on-site workers or the environment) must be weighed against the time to reach cleanup levels.

4.1.2.4 Implementability

Under this criterion, the technical and administrative feasibility of implementing each alternative is evaluated. The availability of needed materials and services is also considered. The technical feasibility considerations include the technical difficulties anticipated in construction, reliability of the selected technology, and ease of implementing the remedy. Administrative feasibility considers coordination of interested parties, as well as any required permits.

4.1.2.5 Cost

Cost estimates were calculated using capital costs (including both direct and indirect costs), annual

O&M costs, and present value of capital and O&M costs. Cost estimates were developed according to *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000) and a 7% discount rate was assumed for all future (i.e., O&M) costs. The cost estimates are based on quotes obtained from New Jersey vendors and disposal facilities, RS Means construction cost data, and previous experience with similar projects. Cost estimates were compiled for the remedial action alternatives using typical construction scenarios assumed for the existing conditions and may be subject to change during the final design process. The provided cost estimates are primarily for the purpose of comparing remedial action alternatives at an accuracy level of -30 to +50 percent, not for establishing project budgets.

4.2 IRP SITE 3: INDIVIDUAL ANALYSIS OF ALTERNATIVES

The following alternatives will be evaluated in detail with respect to the Threshold Criteria and Primary Balancing Criteria discussed above:

Alternative 1: No Action

Alternative 2: MNA

Alternative 3: AS/SVE and MNA

Alternative 4: ISCO and MNA

4.2.1 Alternative 1 – No Action

4.2.1.1 Description

A “No Action Alternative” provides a baseline for evaluating other remedial action alternatives and is compliant with USEPA guidance (USEPA, 1988). Under this alternative, no remedial action would be taken, and any identified contaminants are left “as is” without the implementation of any containment, removal, treatment, or other protective measures. This alternative does not provide for site monitoring and does not provide for any active or passive ICs to reduce the potential for exposure.

4.2.1.2 Evaluation

Overall Protection of Human Health and the Environment: The No Action alternative provides no control of exposure to the contaminated groundwater and no reduction in risk to human health or the environment. It also allows for the concentrations of PCE, chloroform, and naphthalene to remain in the groundwater at unacceptable concentrations.

Compliance with ARARs: Because no action is being taken under this alternative, it will not meet the ARARs for groundwater.

Long-Term Effectiveness and Permanence: This alternative provides no controls for exposure and no long-term management measures. While the PCE plume may naturally attenuate over the long-term through advection/dispersion processes, these reductions will not be documented and will not be confirmed. Therefore, site closure cannot be obtained through this alternative.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Because no remedial technologies are proposed, this alternative will not reduce the toxicity, mobility, or volume of contaminants through treatment. The concentration of PCE within the groundwater will continue to exceed 1 µg/l, as no action will be taken to reduce or isolate contamination in the groundwater. This alternative will also not provide any action to address potential exposure pathways or migration due to transport. The No Action alternative does not meet USEPA's statutory preference for treatment. Therefore, this alternative will not meet this criterion.

Short-Term Effectiveness: This alternative will be ineffective during the short-term. Risks, or potential risks, to both human and ecological receptors remain unchanged under the No Action alternative. This alternative would not remove, isolate, or treat contaminated groundwater at the site. Accordingly, the residual risks presented by the contaminated groundwater would be equivalent to the current levels of risks presented by the site for an extended period of time (approximately 40 years).

Implementability: The No Action alternative does not involve any construction and, therefore, could be implemented immediately. Issues concerning the availability of services, equipment, space, utilities, or manpower are not relevant for this alternative, and coordination with other agencies or permits is not required.

Cost: There are no costs associated with this alternative.

4.2.2 Alternative 2 – MNA

Alternative 2 (MNA) includes the following elements:

- CEA establishment; and,
- MNA until site closure.

4.2.2.1 Description

MNA relies on the subsurface attenuation processes to achieve site-specific RAOs as compared to other more active methods. Natural attenuation processes active in the MNA approach typically include physical, chemical, and/or biological processes that act without human intervention to reduce mass, toxicity, volume, mobility, or concentration of contaminants. In an aerobic environment, such as Site 3, PCE naturally attenuates through the physical processes of advection and dispersion.

In order to monitor the progress of MNA and ultimately obtain site closure, a groundwater monitoring program would be needed. Several monitoring wells are currently positioned to monitor the natural attenuation of site contaminants. However, it may be necessary to install additional wells to adequately monitor natural attenuation parameters and plume characteristics. Monitoring well locations would be decided based on discussions with project stakeholders. After eight rounds of preliminary monitoring to ensure MNA is occurring at the site, a CEA, documenting the nature and extent of contamination and an estimation of time needed to reach

acceptable concentrations of PCE, would be designated and use of groundwater from this area would be restricted. CEAs are established to serve as an IC by providing notice that there is groundwater pollution in a localized area caused by a discharge at a contaminated site. A CEA typically consists of a written and mapped description of the impacted area, an identification of the contaminants for which the CEA has been established (PCE at IRP Site 3), and an estimate of the longevity of the CEA. The NJDEP will establish a groundwater CEA and issue a final CEA Permit Fact Sheet establishing the CEA and its expiration date. The CEA will remain in effect until monitoring indicates that PCE concentrations at IRP Site 3 are less than 1 µg/l. In addition, a RAP would be obtained through the NJDEP and renewed until the site reaches closure. *general comment #1 and EPA*

The remainder of the monitoring program would be conducted as required by NJDEP until levels of COCs are reduced to concentrations below cleanup levels. As previously discussed in Section 1.8.1, the BIOCHLOR modeling tool, used for screening purposes only, estimated 40 years for the PCE contaminants to naturally attenuate to below the cleanup criteria. One year of quarterly closure groundwater monitoring would be conducted to obtain NFA. Upon an NFA determination, the monitoring wells at the site would be permanently abandoned.

This alternative would also include the development of all required reports, including, but not limited to:

- Long-Term Monitoring Plan;
 - Groundwater Monitoring Reports (it is assumed that a total of 50 groundwater monitoring reports would be required [years 1 and 2 would require quarterly monitoring reports, years 3 through 40 would require annual monitoring reports, and the final year would require quarterly monitoring]);
 - 5-Year Reviews;
 - Well Abandonment/Site Closure Reports; and,
 - No Further Response Action Planned Decision Document.
- Since this is a CERCLA site, ICs will need to be established that will be enforced by EPA.*

4.2.2.2 Evaluation

Overall Protection of Human Health and the Environment: This alternative would protect human health and the environment in the short term by restricting use of the groundwater within the CEA, thereby minimizing exposure pathways. Over the long-term, as advection and dispersion processes occur within the plume, concentrations of PCE will ultimately decline to levels below cleanup criteria (1 µg/l), which is protective of both human health and the environment. This alternative will not be fully protective of human health and the environment until NFA is reached, which is estimated to be approximately 40 years.

Compliance with ARARs: This alternative would ultimately be compliant with chemical-, action-, and location-specific ARARs. The concentrations of PCE will naturally decline over approximately 40 years to acceptable concentrations. The duration of this alternative is relatively long and groundwater standards would not be reached at the site for approximately 40 years.

Long-Term Effectiveness and Permanence: Implementation of this alternative will be effective and permanent in the long-term. The advection and dispersion processes that naturally occur in the PCE plume are permanent and irreversible. This alternative would not result in any residual risk as a result of implementation.

Reduction of Toxicity, Mobility, or Volume through Treatment: While implementation of this alternative will reduce the toxicity of the PCE plume through advection and dispersion processes, no active treatment technologies are proposed for this alternative. Over time, concentrations of PCE will decrease, which will decrease the toxicity, mobility and mass of PCE in the groundwater. However, this alternative does not meet the USEPA statutory preference for selecting remedial actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, and volume of the contaminants.

Short-Term Effectiveness: During the short-term, groundwater use restrictions will be placed on the affected groundwater at IRP Site 3 through a CEA. These restrictions will reduce potential exposure risks to human health and the environment. During remedial actions, works could be exposed to contaminated groundwater during well installation and groundwater monitoring activities. These risks will be mitigated through use of proper personal protective equipment (PPE).

It is not expected that the PCE plume will expand off-Base or more than approximately 300 feet further downstream of its current location, reducing potential exposure to residents/workers nearby. Risks associated with this alternative will not be eliminated until RAOs are achieved after approximately 40 years.

Implementability: Implementation of this alternative is relatively easy. Initially, the establishment of ICs will be required by the NJDEP groundwater CEA rules, to limit access to impacted groundwater during long-term monitoring activities. After the CEA is established, a RAP for natural attenuation would be applied for through the NJDEP. Once a permit is obtained, long-term monitoring of PCE would commence until concentrations reach cleanup levels. All services required (NJDEP permitting, monitoring well installation, environmental sampling activities, laboratory analysis, environmental reporting) are readily available.

Cost: The total present value of this option is estimated to be \$420,000, which includes the equipment and labor associated with, but not limited to, NJDEP permitting, monitoring well installation, environmental sampling activities, laboratory analysis, and environmental reporting. The initial cost of this alternative is relatively inexpensive as no active remediation will be conducted. **Table 4-1** presents the estimated costs for Alternative 2. A detailed cost estimate is provided in **Appendix D**.

Table 4-1. Cost Summary for IRP Site 3 Alternative 2 – Monitored Natural Attenuation

Description	Total Cost	Total Present Value ^a
Capital Costs	\$19,250	\$19,250
System Design and Management	\$3,850	\$3,850
Operation and Maintenance Costs	\$212,500	\$108,871
Reporting	\$650,000	\$245,496
Contingency ^b	\$88,560	\$37,747
Total ^c	\$970,000	\$420,000

Notes: ^a Present value based on 7% discount rate.

^b Contingency is 10% of total project cost.

^c Total Cost and Total Present Value are rounded to nearest \$10,000.

IC cost?
(includes
annual
reports)

4.2.3 Alternative 3 – AS/SVE and MNA

spell out

Alternative 3 (AS/SVE and MNA) includes the following elements:

- Pilot study; IC
- CEA establishment;
- Active remediation via AS/SVE system(s) in source areas; and,
- MNA until site closure.

4.2.3.1 Description

Alternative 3 involves establishing ICs, implementing an AS/SVE system within Areas 1 and 2, and long-term monitoring until RAOs are achieved. As with Alternative 2, the first step in the implementation of Alternative 3 is the establishment of a CEA for IRP Site 3 and a RAP, which would be obtained as described in the previous alternative.

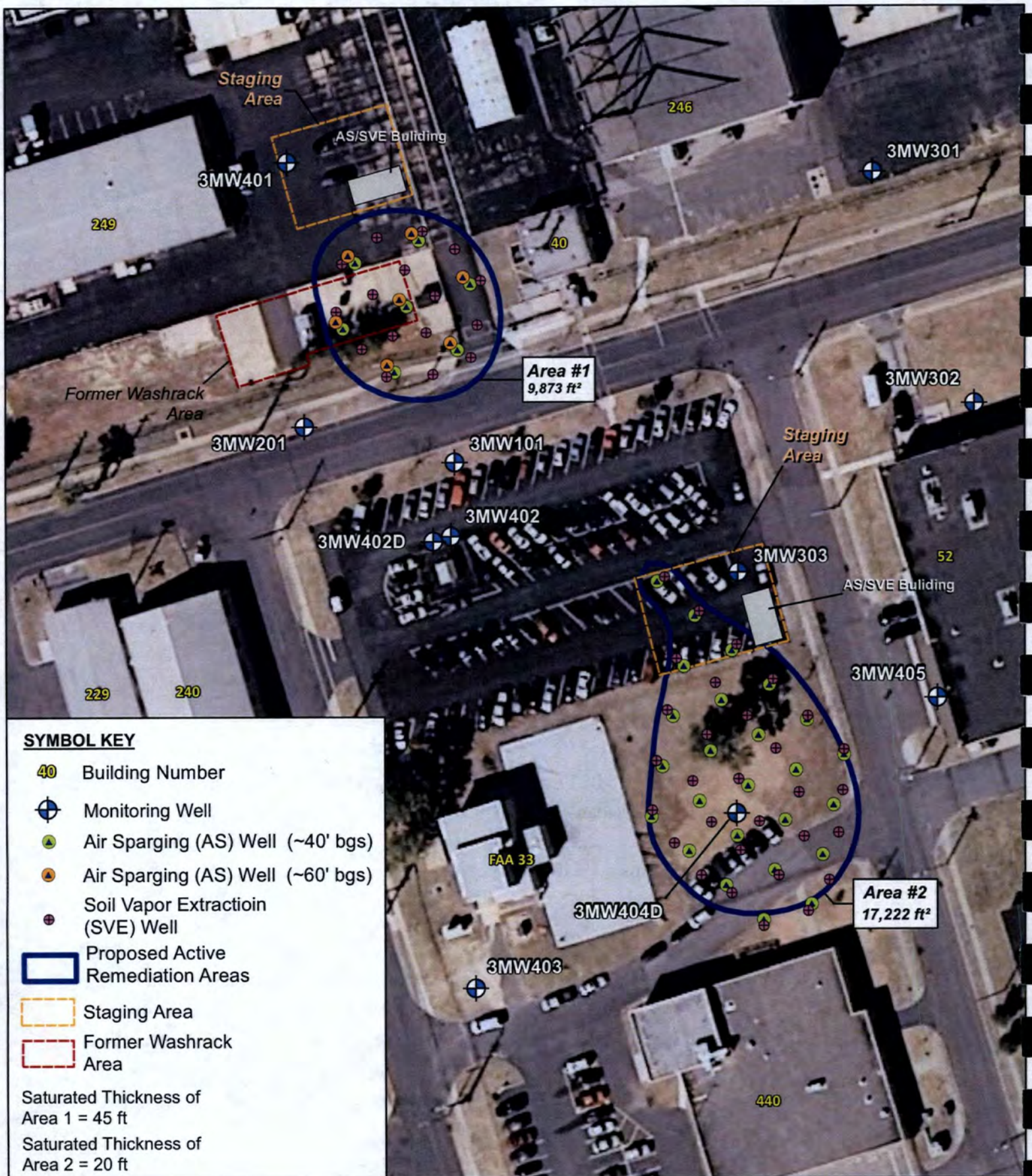
General Comment #1

AS/SVE systems include AS wells and SVE wells. Typically, more SVE wells are installed than AS wells (or more air is extracted than injected) to ensure that all vapor created by the AS system is captured. Because Areas 1 and 2 are different in size and depth of contamination, a separate AS/SVE system will be installed in each area. For screening purposes, assumptions for radius of influence (ROI) were made for AS and SVE wells.

Area 1

Based on the areal extent and depth of Area 1, it is assumed that AS wells at 60 ft bgs will have a 20 ft ROI and the AS wells at 40 ft bgs and SVE wells will have a 15 ft ROI. Based on these assumptions and as shown in **Figure 4-1**, it is estimated that there will be:

- 7 AS wells (at a depth of approximately 60 ft bgs),
- 7 AS wells (at a depth of approximately 40 ft bgs), and
- 16 SVE wells (at an approximately depth of 15 ft bgs).

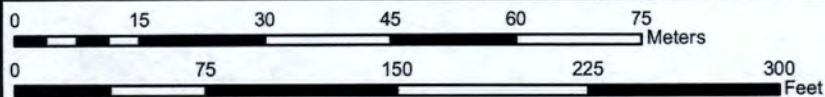


**New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, NJ**



**FIGURE 4-1
IRP Site 3 Alternative 3: Air Sparging/
Soil Vapor Extraction and MNA**

Feasibility Study Report - New Jersey Air National Guard
177th Fighter Wing, Egg Harbor Township, New Jersey



11/01/2011

PROJ: 276220119

File: E_Harbor_NJ_ANG_Site3_air_sparging
soil_vapor_extraction_10.mxd

Drawn: JBO

Note: Two injection depths are proposed for Area 1 to ensure that the maximum amount of air is injected into the 45 ft thick saturated/contaminated zone.

Area 2

Because the depth of contamination for Area 2 is shallower than that of Area 1 and the ROI of AS well increases with depth, the ROI of the Area 2 AS wells is assumed to be 15 ft. The SVE wells will also have a ROI of 15 ft. As shown in **Figure 4-1**, it is estimated that there will be:

- 25 AS wells (at a depth of approximately 40 ft bgs); and
- 30 SVE wells (at an approximately depth of 15 ft bgs).

The “engine” of AS/SVE systems are the air compressors which supply the AS wells with air, and the vacuum blowers that draw in volatilized contaminants. In order to determine the type of air delivery equipment required for each system, the required air pressure for each system must be determined. Because there are two depths of AS wells in Area 1, it is assumed that two compressors will be needed for this system to ensure the pressure is distributed as uniformly as possible. The required air pressure (P_{req}) for each system is based on the sum of the hydrostatic pressure (P_H), the pressure loss ($P_{friction}$), and the air entry pressure ($P_{formation}$). The hydrostatic pressure, which is dependent on the water column in each well, will be the driver for sizing the compressor. Based on the well depths, it is assumed a rotary claw type compressor will be required for each system, which can handle up to approximately 40 pounds per square inch (psi).

The required volume of air to be injected, expressed in cubic feet per minute (cfm) for each AS system will determine the size of the compressor. For evaluation purposes, 10 cfm will be assumed for each AS well. Therefore, since there are seven Area 1 deep wells and seven Area 1 shallow wells, a 70 cfm compressor is required for each set of wells. A 250 cfm compressor will be required for Area 2. In order to minimize the creation of preferential pathways in the formation and maximize contact of groundwater with air, the AS compressors will be programmed to pulse air through the system rather than continually push air through the system.

For the SVE component of each system, a rotary lobe/vane blower has been selected. Again assuming each SVE well requires 10 cfm, the vacuum blower for Area 1 will require 160 cfm and the vacuum for Area 2 will require 300 cfm. Prior to actual design of an AS/SVE system, a pilot test is recommended to obtain site-specific design criteria.

Once the PCE has volatilized and the vapors have been removed from the soil, the air stream must be treated prior to discharging into the atmosphere. It is assumed that GAC will be used to treat the vapors through a series of two inline 1,000-pound vessels. The off-gas will be pumped directly from the ground into the GAC vessels. A monitoring point will be installed in between the two vessels to ensure that the GAC is sufficiently treating the air stream and monitor for breakthrough. Because of the relatively low concentrations of PCE in the groundwater, it is not anticipated that the GAC will need to be replaced within the vessels during the operation of the system. However, an air emissions permit will be required by the NJDEP.

It is assumed that each system will be housed in a temporary building in the Staging Areas shown on **Figure 4-1**. Each building will be equipped with a compressor(s), a blower and two GAC cylinders. Piping and a manifold for each well will be installed in the buildings. In addition an automatic Programmable Logic Controller will be installed to shut off the system in the event of a failure in the SVE systems and a telemetric system will be installed by trenching in order to monitor the system remotely.

Piping will be installed from the AS/SVE manifolds to each AS/SVE well. Based on this design, approximately 2,300 linear ft of piping will be required for this alternative. The piping will be trenched and backfilled to minimize disruption to Base operations.

A pilot test is needed to determine the expected removal rate of PCE from each AS/SVE system. However, because volatilization is the only process actively treating the PCE, it is assumed that the AS/SVE systems will remain in operation for three years, after which PCE concentrations are expected to be 20 µg/l.

Upon the shutdown of the AS/SVE systems, the MNA processes would commence. The AS/SVE systems would be decommissioned, the AS/SVE wells would be abandoned, and all system components would be removed from IRP Site 3.

Eight quarters of MNA monitoring would begin as required by the NJDEP. Once MNA parameters have been established and indicate that MNA is effective at the site, a long-term monitoring program would commence in accordance with CEA/NJDEP requirements until levels of COCs are reduced to concentrations below cleanup levels. It is anticipated that PCE concentrations will reach 1 µg/l in less than 30 years after the AS/SVE activities. This estimate is based on the BIOCHLOR model previously discussed and is for screening purposes only. The model was evaluated using the same inputs as discussed in Section 1.8.1, with the exception of the concentration of PCE was changed from 59 µg/l to 20 µg/l (which would be the maximum concentrations within the plume after AS/SVE activities). A copy of the input parameters and outputs of this model simulation are included in **Appendix C**. Upon an NFA determination, the monitoring wells at the site would be permanently abandoned.

This alternative would also include the development of all required reports, including, but not limited to:

- Remedial Action Work Plan (including the results of a pilot study);
- After Action Report;
- Groundwater Monitoring Reports (it is assumed that a total of 46 groundwater monitoring reports would be required [years 1 through 3 would require quarterly monitoring reports, years 4 through 33 would require annual monitoring reports, and the final year would require quarterly monitoring]);
- 5-Year Reviews
- Well Abandonment/Site Closure Reports; and,
- No Further Response Action Planned Decision Document.

Monitoring Program
would be commenced in accordance with NJDEP & EPA requirements
Capped Count #1

It should be noted that the assumptions set forth in this detailed description are for the purposes of this FS and associated costing. It is difficult to predict air distributions due to the sensitivity of air distributions to subtle changes in soil structure without a pilot study. Therefore, a pilot study is recommended prior to implementation of this Alternative, to gather the necessary data for a full scale design. The pilot study would determine the zone of influence at various injection flow rates to determine the optimal rate at each depth, determine the minimum injection pressure, minimum vacuum pressure, and evaluate any adverse effects associated with implementation of the system.

4.2.3.2 Evaluation

Overall Protection of Human Health and the Environment: Alternative 3 would be protective of human health and the environment because the contaminant mass would be reduced. The concentration of PCE within the plume is expected to be reduced to a maximum concentration of 20 µg/l within approximately three years. The RAO of 1 µg/l PCE throughout the aquifer would be met in less than 30 years after MNA. Until the RAOs are achieved, risks to human health will be mitigated through the use of the CEA and risks to remediation workers will be mitigated through use of proper PPE and a Health and Safety Plan.

Compliance with ARARs: The implementation of AS/SVE with MNA would comply with chemical-specific ARARs in the long-term after treatment. PCE concentrations would be reduced to 1 µg/l in less than 30 years after the shutdown of the AS/SVE systems. During the implementation of this alternative, all federal, state and local requirements would be followed, including obtaining a CEA and RAP from NJDEP. In addition, a Permit to Construct/Install/Alter Air Quality Control Apparatus/Equipment (N.J.A.C. 7:27-8) and a Certificate to Operate Air Quality Control Apparatus/Equipment (N.J.A.C. 7:27-8) would be obtained prior to operation of the Systems.

RA/RA General Comment 2
equivalent
Bear Comment 3

Long-Term Effectiveness and Permanence: AS/SVE is a popular remedial technology and has been proven effective at sites worldwide. The sandy soils at the site are ideal for AS/SVE. Volatilization of PCE would occur as injected air reached the contaminated groundwater. However, the effectiveness of this alternative relies primarily on the distribution of air in the subsurface which is difficult to predict. It is possible that the injected air will create preferential pathways, which will minimize the amount of contaminated groundwater treated. Because volatilization is the only means of treatment, the contaminated groundwater would have to flow through these preferential pathways in order for the alternative to be effective.

Once the AS/SVE systems are successful in treating the PCE to concentrations less than 20 µg/l, MNA of the groundwater plume is predicted to reduce the concentrations of PCE to below 1 µg/l in less than 30 years of the system shutdown. While AS/SVE and MNA are both permanent treatments, AS/SVE transfers the compound to a carbon source, which must be recharged at an offsite facility.

Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 3 would reduce the toxicity and volume of contaminated groundwater through the treatment of PCE. In the AS/SVE phase, PCE would be volatilized and adsorbed onto activated carbon. This process reduces the mobility of PCE by containing it within the GAC. However, the volume and toxicity is not necessarily reduced because the contaminant is simply transferred to another state. During MNA, toxicity, mobility and volume are all reduce. However, since MNA is not considered an active treatment, it does not satisfy the USEPA preference for reduction through treatment.

This alternative does meet the USEPA statutory preference for selecting remedial actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, and/or volume of the contaminants.

Short-Term Effectiveness: Alternative 3 would be effective in the short-term because it will reduce the PCE concentrations in the plume in the short-term, thereby reducing the potential exposure to contaminants. It is estimated that the highest concentrations of PCE would be reduced to below 20 µg/l within 1 year of the startup of the systems. During implementation of the alternative, the community would be protected by limiting exposure through the CEA. Installation of injection and monitoring wells would involve drilling into contaminated groundwater. Therefore, procedures and precautions would be implemented to minimize worker exposure to contaminants and all remediation workers would be trained in hazardous waste operations as mandated by 29 CFR 1910.120.

Implementability: AS/SVE with MNA is readily implementable as it is a common remediation technology. AS/SVE equipment is readily available and "off-the-shelf" systems may be found. A source of power is assumed to be available at the site to run both systems, which will operate 24/7 for approximately three years. The equipment and procedures for collecting and monitoring groundwater samples are routine.

During the installation of the systems, several thousand feet of piping will be trenched primarily in the parking lots above the treatment zone. This could cause some disruption to the base, but care would have to be exercised to minimize disruption. Once the systems are fully operational, they will have little effect on day-to-day Base operations.

Prior to implementation, permits, such as a RAP and air quality control equipment permits, would have to be obtained.

Cost: The present value cost of Alternative 3 for IRP Site 3 is estimated to be \$1,990,000, which includes the equipment and labor associated with, but not limited to the AS/SVE system installation, NJDEP permitting, environmental sampling activities, long-term system O&M, laboratory analysis, and pilot testing. These costs also include MNA monitoring and reporting for an estimated 30 years. The following assumptions were made in the development of this alternative and cost estimate:

- ROIs for AS and SVE wells is 15 ft with the exception of the deep AS wells in Area 1,

- which have an assumed ROI of 20 ft;
- injection and extraction rates are 10 cfm per well;
- each system will run for three years;
- power will be available for use during system operation from nearby transformers and one power drop will be needed; and,
- work days are 12 hour days, five days a week.

Table 4-2 presents the estimated costs for Alternative 3. A detailed cost estimate is provided in **Appendix D**.

Table 4-2. Cost Summary for IRP Site 3 Alternative 3 – AS/SVE and MNA

Description	Total Cost	Total Present Value ^a
Capital Costs	\$791,150	\$791,150
System Design and Management	\$181,965	\$181,965
Operation and Maintenance Costs	\$344,300	\$210,992
Reporting	\$630,000	\$469,484
Contingency ^b	\$389,483	\$356,396
Total ^c	\$2,340,000	\$1,990,000

Notes: ^a Present Value based on 7% discount rate.

^b Contingency is 20% of total project cost.

^c Total Cost and Total Present Value are rounded to nearest \$10,000.

4.2.4 Alternative 4 – In-Situ Chemical Oxidation and MNA

Alternative 4 (ISCO with MNA) includes the following elements:

- Pilot study;
- CEA establishment;
- Active remediation via ISCO of areas containing PCE concentrations of 20 µg/l or greater; and,
- MNA until site closure.

4.2.4.1 Description

As with Alternatives 2 and 3, the first step in the implementation of Alternative 4 is the establishment of a CEA for IRP Site 3 and a RAP, which would be obtained as described in the previous alternatives.

Once the CEA has been established and the RAP is obtained from NJDEP, Areas 1 and 2 (both of which contain PCE concentrations exceeding 20 µg/l) would be actively treated. Injection and monitoring wells would be constructed first. Treatment Area 1 has a surface area of 9,873 ft² and a saturated thickness of approximately 45 feet. The injection wells are assumed to each have 15-foot screens, located at the bottom of each well, and an ROI of 15 feet. Therefore, it is assumed that 14 injection locations would sufficiently cover this target area (**Figure 4-2**). Each injection location would have a cluster of three wells. Each of the three wells would be screened at a different interval to provide coverage over the entire 45 feet of saturated thickness. This

would bring the total number of injection wells at Area 1 to 42. Using the same logic for Area 2, 24 well locations with two wells in each location (to sufficiently treat the saturated thickness of 20 feet) would be required. The total number of injections wells at both sites would be 90 wells (at 38 locations). It is anticipated that both the injection wells and monitoring wells would be installed using a standard drill rig and each well would be a 2-in polyvinyl chloride (PVC) flush-mounted well to minimize impacts to the Base.

3 After the injection wells are established, monitoring wells would be installed within each treatment area in order to determine the effectiveness of the injections. It is anticipated that two wells will be installed in Area 1 and three wells in Area 2. In addition, existing monitoring wells would also be monitored to either determine the effectiveness of the injections or monitor plume migration, if any.

4 The next phase of this alternative is the actual injection of sodium permanganate (NaMnO_4). Several different chemical oxidants (i.e., persulfate, Fentons Reagent™) were evaluated. Sodium permanganate was selected for both cost and performance purposes. Permanganate has a longer half-life compared to more powerful oxidants and will persist in the subsurface longer than other oxidants. As a result, it can migrate by diffusion or post-injection advective flow and react with contaminants that other oxidants might not be able to reach. Although available in a solid form as potassium permanganate, the liquid form is proposed for use at IRP Site 3 to eliminate mixing dry powder on site, thereby minimizing potential health and safety issues.

5 The required level of effort for conducting successful ISCO was determined by calculating the quantity of groundwater being targeted for treatment. In evaluating the available site data and assuming a porosity of 30%, it was determined that Area 1 contained 996,976 gallons of contaminated groundwater, and Area 2 contained 772,924 gallons of contaminated groundwater (1,769,900 gallons total). Again, contaminated groundwater is considered to be groundwater which exceeds PCE concentrations of 20 $\mu\text{g/l}$.

6 The amount of chemical oxidant (NaMnO_4) required is a function of native soil oxidant demand and COC concentrations. Although no native soil oxidant demand samples have been analyzed, for purposes of screening this alternative, a sodium permanganate loading rate of 0.1 g/kg is assumed. As shown in the equations below, the required amount of oxidant can be estimated using this loading rate, an estimated soil bulk density of 2,700 pounds per CY, and an assumed 0.05% concentration (or 500 mg/l) of sodium permanganate.

$$\text{Soil bulk density} = 2700 \frac{\text{lbs}}{\text{CY}} * \frac{1 \text{ kg}}{2.2 \text{ lbs}} = 1227.3 \frac{\text{kg}}{\text{CY}}$$

Total mass of NaMnO_4 for 1 yd^3 assuming a loading rate of 0.1 g/kg:

$$0.1 \frac{\text{g}}{\text{kg}} * 1227.3 \frac{\text{kg}}{\text{CY}} = 122.7 \frac{\text{g}}{\text{CY}}$$

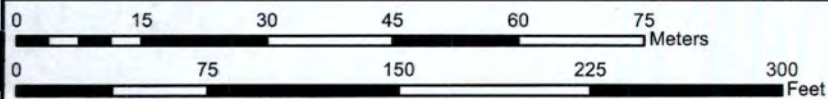


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FIGURE 4-2
IRP Site 3 Alternative 4: In-Situ
Chemical Oxidation and MNA

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177th Fighter Wing, Egg Harbor Township, New Jersey



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_In-Situ_Chem_Ox_MNA_10.mxd

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The required amount of 40% NaMnO₄* per gallon of injected water is:

$$500 \frac{mg}{l} * \frac{1g}{1000mg} * \frac{1kg}{1000g} * \frac{2.2 lbs}{1 kg} * \frac{3.8 l}{gal} * \left(\frac{1}{0.40} \right) = 0.01045 \frac{lbs \text{ 40\% NaMnO}_4}{gal}$$

*NaMnO₄ typically is sold in a 40% solution.

1 The total volume of contaminated groundwater in Areas 1 and 2 is estimated to be 1,769,900 gallons. To achieve a 0.05% concentration of sodium permanganate in the aquifer, 18,496 lbs or 1,608 gallons of 40% NaMnO₄ will be required for the first injection.

2 In order to inject in eight wells simultaneously at 2 gallons per minute (gpm), two 20,000-gallon frac tanks of water would be connected to a base hydrant to batch mix the sodium permanganate to the effective dosing rate. The frac tanks and drums of sodium permanganate, along with all other necessary injection equipment and supplies will be staged in Area 1 and 2 as shown in **Figure 4-2**. Other injection equipment will include a chemical feed pump, a transfer pump, an in-line static mixer, a piping manifold, as well as, flow meters, valves, and pressure gauges for each injection well. The sodium permanganate would be mixed with water from a 20,000 gallon frac tank using an in-line static mixer. It is assumed that water from a base hydrant will be used to fill the frac tanks. The mixed solution would be distributed via a piping manifold which would split the flow into eight separate flexible pipes such that the solution could be simultaneously injected into eight injection wells. The injection rates and injection pressures for each individual application point will be monitored using in-line flow meters on the piping manifold and pressure gauges located at the hose connection to each application well head. The delivery flow rate to each application point will be controlled using valves located on the piping manifold.

9 Upon completion of the first ISCO injection, performance monitoring will be conducted to monitor post-remedial effectiveness. It is anticipated that the performance monitoring will indicate a need for an additional ISCO injection. Due to the persistent nature of permanganate, it is assumed that the second injection would commence approximately six months after the first. The second round of injections will be at an assumed 50% level of effort from the first round.

10 Performance monitoring will be conducted again to determine the effectiveness of the second ISCO treatment. It is assumed that the results of the performance monitoring will indicate that PCE concentrations within Areas 1 and 2 are below 20 µg/l. Once it has been established that no additional injections are required and the injection remedy itself is considered complete, a MNA program would begin. The injection wells would be abandoned at the completion of the treatment period, which is anticipated to be approximately one year.

11 Eight quarters of MNA monitoring would begin as required by the NJDEP. Once MNA parameters have been established and indicate that MNA is effective at the site, a long-term monitoring program would commence in accordance with CEA/NJDEP requirements until levels of COCs are reduced to concentrations below cleanup levels.

The MNA monitoring plan must also be approved by EPA

It is anticipated that PCE concentrations will reach 1 µg/l in less than 30 years after the active treatment/injection activities. Upon a NFA determination, the monitoring wells at the site would be permanently abandoned.

This alternative would also include the development of all required reports, including, but not limited to:

- Remedial Action Work Plan (including the results of a pilot study);
- After Action Report;
- Groundwater Monitoring Reports (it is assumed that a total of 42 groundwater monitoring reports would be required [years 1 and 2 would require quarterly monitoring reports, years 3 through 32 would require annual monitoring reports, and the final year would require quarterly monitoring]);
- 5-Year Reviews;
- Well Abandonment/Site Closure Reports; and,
- No Further Response Action Planned Decision Document.

It should be noted that the assumptions set forth in this detailed description are for the purposes of this FS and associated costing. Prior to implementation of this Alternative, a pilot study is needed to gather the necessary data for a full scale ISCO design. The pilot study would minimally consist of groundwater and soil oxidant demand analysis, which would refine the assumptions associated with injection rates and optimal sodium permanganate concentrations for the impacted groundwater.

4.2.4.2 Evaluation

Overall Protection of Human Health and the Environment: Alternative 4 would be protective of human health and the environment because the contaminant mass would be reduced. The concentration of PCE within the plume is expected to be reduced to a maximum concentration of 20 µg/l within approximately one year (assuming two injections). The RAO of 1 µg/l PCE throughout the aquifer would be met in less than 30 years after the ISCO implementation through the use of MNA. Until the RAOs are achieved, risks to human health will be mitigated through the use of institutional controls (CEA) and risks to remediation workers will be mitigated through use of proper PPE and a Health and Safety Plan.

Compliance with ARARs: The implementation of ISCO with MNA would comply with chemical-specific ARARs in the long-term after treatment. PCE concentrations would be reduced to 1 µg/l in less than 30 years after ISCO implementation. During the implementation of this alternative, all federal, state and local requirements would be followed, including obtaining a CEA and RAP from NJDEP. *Gen Com 2*

Long-Term Effectiveness and Permanence: Alternative 4 would be effective and permanent in the long-term. Destruction of PCE within the injection zone would permanently reduce PCE concentrations to below 20 µg/l. Following ISCO activities, MNA of the groundwater plume is

predicted to reduce the concentrations of PCE to below 1 µg/l in less than 30 years. The use of both ISCO and MNA are permanent and irreversible solutions.

ISCO is a proven technology that would be effective in destroying significant quantities of PCE in the injection zone, as well as downgradient concentrations. Although most, if not all, of the saturated thickness of the contaminant plume would be screened in each cluster of injection wells to distribute permanganate vertically, case studies have indicated that much of the injectant enters the formation at the top of the well screen, where the hydraulic pressure is at a minimum. However, it is anticipated that due to the persistent nature of permanganate, there would be sufficient time for diffusion to occur throughout the entire formation.

Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 4 would reduce the toxicity and volume of contaminated groundwater through permanent treatment of PCE through chemical oxidation. While the mobility of residual PCE in groundwater plume itself will not be affected, the reduction of PCE concentrations will prevent the migration of the groundwater plume in the long term primarily by advection and dispersion processes. This alternative does meet the USEPA statutory preference for selecting remedial actions that employ treatment technologies to permanently and significantly reduce toxicity, mobility, and/or volume of the contaminants.

Short-Term Effectiveness: Alternative 4 would be effective in the short-term by quickly reducing PCE concentrations and potential exposure to contaminants. It is estimated that the highest concentrations of PCE would be reduced to below 20 µg/l in less than one year of implementation. During execution of the alternative, the community would be protected by limiting exposure through institutional controls (CEA).

Installation of injection and monitoring wells would involve drilling into contaminated groundwater and the injection process would require remediation workers to handle sodium permanganate, a strong oxidizer and hazardous material. Therefore, procedures and precautions would be implemented to minimize worker exposure to contaminants and all remediation workers would be trained in hazardous waste operations as mandated by 29 CFR 1910.120.

Implementability: ISCO would be readily implementable. Items of equipment needed to inject oxidant solution into groundwater are well established, consisting of injection wells, distribution headers and piping, flow meters, and pumps. Sodium permanganate is commercially available and has been used to oxidize significantly greater levels of contamination (including PCE) at other sites. A source of power is available at the site to run the injection pumps. Injections would occur over a period of 3 weeks, with subsequent injections occurring approximately six months later, if needed. The equipment and procedures for collecting and monitoring groundwater samples are routine.

Water for blending and delivery of the reagents is assumed to be available onsite. Delivery of the permanganate solution to the injection wells would be provided through control valves and pipes.

Sufficient space is available at each Area for the two anticipated injection activities and the staging areas are located in parking lots near each area (See **Figure 4-2**).

Although care would have to be exercised to avoid disrupting Base operations during well installation and injection activities, it is assumed that these activities would have a minimal footprint or effect on day-to-day Base operations. Prior to implementation, permits, such as a RAP and an underground injection permit, would be obtained.

Cost: The present value cost of Alternative 4 for IRP Site 3 is estimated to be \$1,360,000, which includes the equipment and labor associated with, but not limited to the well installation, injection activities, NJDEP permitting, environmental sampling activities, laboratory analysis and pilot testing. These costs also include O&M costs (groundwater monitoring and reporting) for an estimated 30 years. The following assumptions were made in the development of this alternative and cost estimate

Gen Cont 3

- porosity is 30%;
- injection rate is 2 gpm per well;
- active injection can take place concurrently at eight wells;
- injection volume is 10% of the total volume of contaminated groundwater;
- amount of 40% permanganate solution required to treat groundwater to 20 µg/l is 0.01045 pounds per gallon of water;
- alternative will consist of two rounds of injection (the second injection have a 50% level of effort compared to the first injection);
- fire hydrants will be available for use during injections; and,
- work days are 12 hours per day, five days a week.

Table 4-3 presents the estimated costs for Alternative 4. A detailed cost estimate is provided in **Appendix D**.

Table 4-3. Cost Summary for IRP Site 3 Alternative 4 – ISCO and MNA

Description	Total Cost	Total Present Value ^a
Capital Costs	\$685,260	\$685,260
Design and Management	\$102,789	\$102,789
Operation and Maintenance Costs	\$159,600	\$70,298
Reporting	\$590,000	\$377,008
Contingency ^b	\$153,765	\$123,536
Total ^c	\$1,690,000	\$1,360,000

Notes:

^a Present Value based on 7% discount rate.

^b Contingency is 10% of total project cost.

^c Total Cost and Total Present Value are rounded to nearest \$10,000.

4.3 SITE 6: INDIVIDUAL ANALYSIS OF ALTERNATIVES

The following alternatives will be evaluated in detail with respect to the criteria discussed above:

Alternative 1: No Action

Alternative 2: Excavation and Disposal

4.3.1 Alternative 1 – No Action

4.3.1.1 Description

As stated previously, the “No Action Alternative” provides a baseline for evaluating other remedial action alternatives and is compliant with USEPA guidance (USEPA, 1988). Under this alternative, no remedial action would be taken, and any identified contaminants are left “as is” without the implementation of any containment, removal, treatment, or other protective measures. This alternative does not provide for site monitoring and does not provide for any active or passive ICs to reduce the potential for exposure.

4.3.1.2 Evaluation

Overall Protection of Human Health and the Environment: The No Action alternative provides no control of exposure to the contaminated soil and no reduction in risk to human health or the environment. It also allows for the concentrations of lead and PAHs in the surface soils at IRP Site 6 to remain at unacceptable concentrations.

Compliance with ARARs: Because no action is being taken under this alternative, it will not meet the ARARs for soil and site closure is not possible.

Long-Term Effectiveness and Permanence: This alternative provides no controls for exposure and no long-term management measures. Therefore, this alternative will not be effective in reaching site closure and will not be effective in the long-term.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Because no remedial technologies are proposed, this alternative will not reduce the toxicity, mobility, or volume of contaminants through treatment. Therefore, this alternative will not meet this criterion.

Short-Term Effectiveness: This alternative will be ineffective during the short-term. This alternative will not mitigate potential risks to human receptors and does not meet this criterion.

Implementability: There are no actions required to implement this alternative. There would not be any technical or administrative difficulties in implementing this alternative.

Cost: There are no costs associated with this alternative.

4.3.2 Alternative 2 – Excavation and Disposal

4.3.2.1 Description

This alternative includes the physical removal of soil from the extents shown in **Figure 4-3** and subsequent offsite disposal. Based on soil analytical data the excavation area at IRP Site 6 will

be approximately 1,100 ft² to a depth of approximately 6 inches bgs with a total volume of soil to be removed and disposed approximately 29 CY or 39 tons. ^{Post excavation sampling?} The contaminated soil will be excavated using a small track excavator or similar equipment. Soil will be direct loaded into roll-off containers and waste characterization samples collected. It is assumed that the waste will be characterized as non-hazardous. ^{refer to off-site cont.} The roll-offs will then be transported to a permitted Subtitle D disposal facility and disposed of as non-hazardous waste. Site restoration following the remedial work will include backfilling with certified clean fill and/or topsoil, soil compaction, final grading, soil stabilization, and seeding in accordance with Base specifications.

Excavation with off-site disposal is an effective remedial option, and is technically feasible for the removal of soil contamination at IRP Site 6, given that equipment and materials are readily available. This alternative would further protect human health and the environment by reducing the mobility, toxicity, and volume of contaminants through removal. This alternative will also meet the ARARs at IRP Site 6.

4.3.2.2 Evaluation

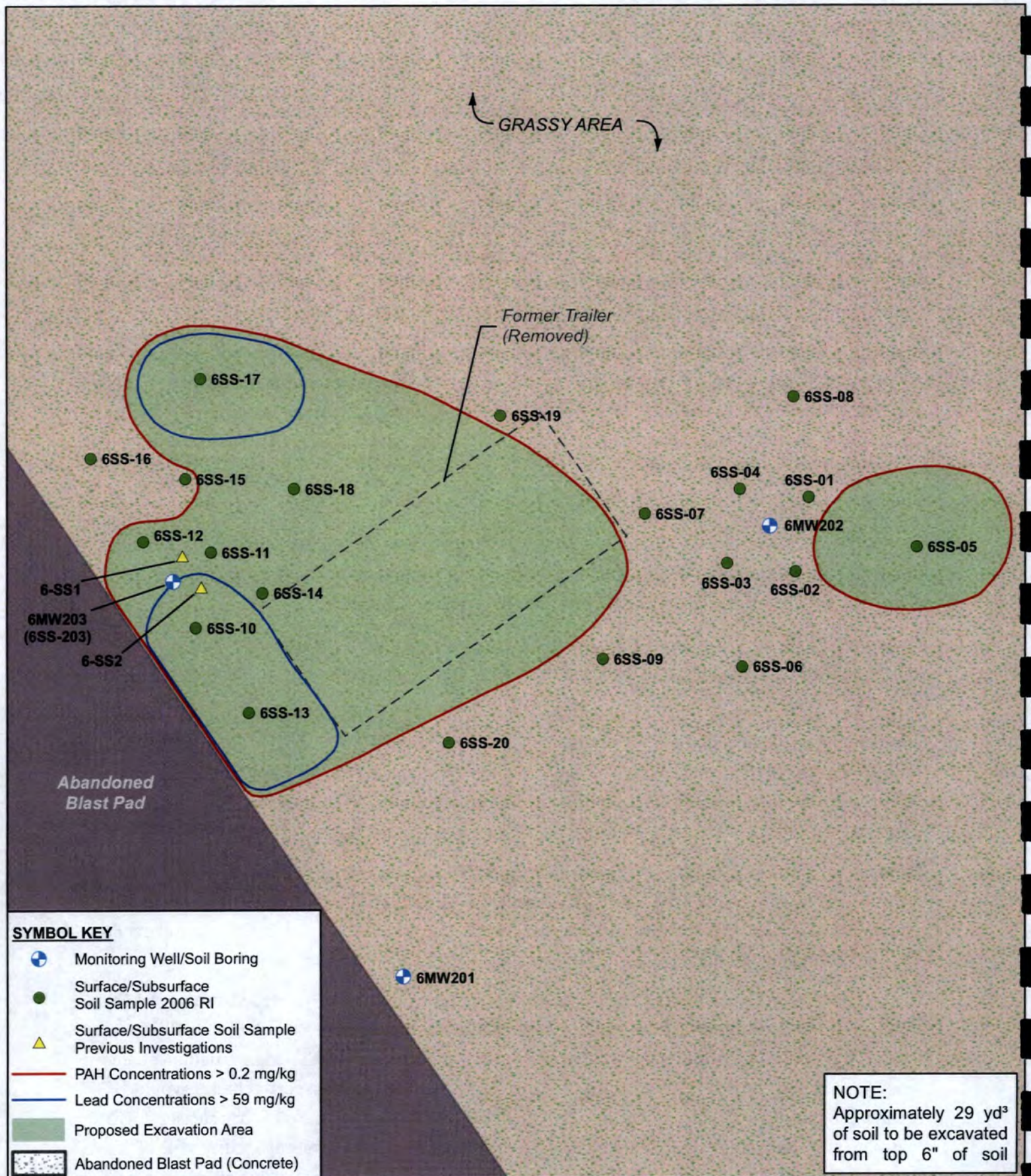
Overall Protection of Human Health and the Environment: This alternative would protect human health and the environment in both the short-term and the long-term as it would remove the risks associated with adverse lead and PAH concentrations in surface soils.

Compliance with ARARs: This alternative will comply with ARARs and protect human health and the environment by removing the impacted soil from the site.

Long-Term Effectiveness and Permanence This alternative will effectively reduce and/or eliminate the risk associated with contaminated surface soil at IRP Site 6 because it proposes to remove the entire impacted area. Excavation of the impacted area would continue until confirmatory samples indicate that concentrations are below the NJDEP cleanup criteria. This alternative provides a permanent solution and will not require any long-term O&M.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative does not reduce the principal threats of the lead and PAH impacted soil through the destruction or irreversible reduction in the mass of contaminants. Because the RAOs will not be met utilizing a treatment process, this alternative does not meet this criterion.

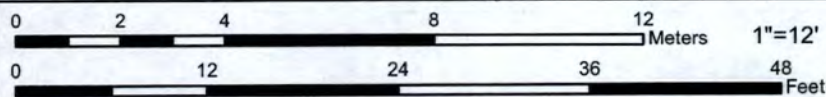
Short-Term Effectiveness: This alternative will pose short-term risks to remediation workers during its implementation. These risks will be mitigated through the use of proper PPE and engineering controls. Additional risks would be encountered during the transportation of the contaminated soil; however, these risks are considered minimal as transport vehicles would be equipped with appropriate protective controls to minimize the risk of a release. No environmental impacts from this alternative are anticipated and the disposal facility will be an USEPA approved facility meeting all necessary containment requirements. This alternative will also provide a relatively short remedial response time.



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FIGURE 4-3
IRP Site 6 Alternative 2: Excavation & Disposal
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Implementability: Implementation of this alternative is technically feasible and labor and equipment needed for implementation are readily available. This alternative uses reliable and proven technologies and is estimated to take approximately one week to implement (with site closure anticipated within one year). Uncertainties do exist with the implementation of this alternative because the utilities have not been identified. However, due to the site's proximity to the blast pad, utilities are not expected to be located within the area proposed for excavation. All work associated with this alternative would be coordinated through the Base. The estimated timeframe to complete this alternative through site closure is 12 months.

Cost: The present value of excavation with off-site disposal would be approximately \$60,000. **Table 4-4** presents the estimated costs for Alternative 2. A detailed cost estimate is provided in **Appendix D**.

Table 4-4. Cost Summary for IRP Site 6 Alternative 2 – Excavation and Disposal

Description	Total Cost	Total Present Value ^a
Capital Costs	\$13,815	\$13,815
Design and Management	\$2,487	\$2,487
Operation and Maintenance Costs	\$0	\$0
Reporting	\$40,000	\$40,000
Contingency ^b	\$5,630	\$5,630
Total ^c	\$60,000	\$60,000

Notes:^a Present Value based on 7% discount rate.

^b Contingency is 10% of total project cost.

^c Total Cost and Total Present Value are rounded to nearest \$10,000.

4.4 COMPARATIVE ANALYSIS

The alternatives were each given a ranking for each of the evaluation criteria. In this analysis, the remedial alternatives were compared to each other to determine which alternative best satisfied the criteria and why. Each alternative has been numerically evaluated using a scale from 1 to 5. A ranking of “1” denotes unsatisfactory performance in the category, a “2” denotes below-average performance in the category, a “3” denotes moderate performance in the category, a “4” denotes good/acceptable performance in the category and “5” denotes excellent performance in the category. Therefore, the alternative with the highest numerical sum will be the preferred remedial alternative. A summary of the results of this analysis is provided in **Tables 4-5** and **4-6**.

4.4.1 IRP Site 3

Alternative 1 (No Action) does not meet either of the threshold criteria necessary to be selected as the preferred alternative. Therefore, based on the performance in the primary balancing criteria, this alternative is not eligible for selection and will not be further discussed/evaluated.

Alternatives 2, 3 and 4 would achieve overall protection of human health and the environment in the long-term and will comply with ARARs. Alternatives 3 and 4 both consist of active

remediation of the source areas, which will prevent plume migration and allow for site closure within 30 years. Alternative 2, MNA, will not prevent plume migration and will not allow for site closure within 30 years. Therefore, Alternative 2 ranks lower in the overall protection of human health and the environment.

In the balancing criteria, the primary distinction between the three alternatives is with regard to the short-term effectiveness and implementability. All three alternatives have an MNA component, which is estimated to take approximately 30 years to reach the ultimate goal of site closure in Alternatives 3 and 4. Alternative 2, however, does not utilize an active treatment in the source areas and therefore, is estimated to take 40 years to reach site closure. The primary difference between Alternatives 3 (AS/SVE and MNA) and 4 (ISCO and MNA) are that Alternative 3 will require the continued O&M of AS/SVE systems, will require a significant amount of energy to operate the AS/SVE systems, and will create a secondary waste stream. In addition, Alternative 3 has more uncertainties associated with the implementability of the remedy primarily because it will require more than 2,300 feet of piping to be trenched. If utilities or underground obstacles are encountered, it could significantly delay the construction of the AS/SVE systems. Alternative 4 does not require a system, consume large amount of energy, or produce a secondary waste stream, but does require remediation workers to handle sodium permanganate. While it is hazardous itself, sodium permanganate will persist in the aquifer until it is fully oxidized, allowing it a greater probability of diffusing into small pore spaces or dead end pores coming into contact with the impacted groundwater. The staying power of the sodium permanganate, coupled with the lack of a secondary waste stream or significant energy consumption, gives Alternative 4 the highest rank in this category.

In the long-term, Alternative 2, 3 and 4 are permanent remedies and each requires the use of MNA to treat the PCE plume. However, Alternative 3 will require continued O&M of the remedial systems while Alternatives 2 and 4 will not. Therefore, Alternatives 2 and 4 rank highest in this category.

Alternative 4 ranks highest in the reduction of toxicity, mobility, or volume through treatment because it will reduce the concentration and mass of PCE through treatment and prevent the migration of the PCE plume. Alternative 3 will reduce the toxicity and mobility of the PCE through treatment, but it will not reduce the overall mass since PCE will be transferred from the aqueous phase in groundwater to a sorbed vapor phase on the carbon. Alternative 2 ranks lowest in this category because it uses a natural process rather than a treatment to reach RAOs.

The total present value of Alternatives 1, 2, 3, and 4 for IRP Site 3 is \$0; \$420,000; \$1,990,000; and, \$1,360,000 respectively.

Table 4-5. IRP Site 3 Summary of Comparative Analysis

Criterion		Alternative 1: No Action	Alternative 2: MNA	Alternative 3: AS/SVE and MNA	Alternative 4: ISCO and MNA
Threshold Criteria	Overall Protection of Human Health and the Environment	1 - would not be protective	3 + would be protective - would not prevent plume migration - would not allow for site closure within ~30 years	5 + would be protective + would prevent plume migration + would allow for site closure within ~30 years	5 + would be protective + would prevent plume migration + would allow for site closure within ~30 years
	Compliance with ARARs	1 - would not comply with ARARs	5 + will comply with ARARs	5 + will comply with ARARs	5 + will comply with ARARs
Primary Balancing Criteria	Long-Term Effectiveness and Permanence	1 - will not be able to verify effectiveness or permanence over the long-term	5 + permanent remedy + no system requiring O&M	3 + permanent remedy - requires continued O&M of AS/SVE systems and significant amount of energy	5 + permanent remedy + no system requiring O&M
	Reduction of Toxicity, Mobility, or Volume through Treatment	1 - would not provide treatment and thus toxicity, mobility or volume would not be reduced through treatment.	2 - does not use active treatment to reduce toxicity, mobility and volume and will not meet USEPA statutory preference for use of treatment + remedy is irreversible	4 + will reduce toxicity and mobility of PCE >20 µg/l through use of treatment, satisfying USEPA statutory preference for use of treatment + remedy is irreversible - will not reduce mass (PCE is transferred onto carbon and will require disposal or regeneration) - MNA will not use treatment as means of reducing toxicity, mobility or volume	5 + will reduce toxicity and mobility of PCE >20 µg/l through use of treatment, satisfying USEPA statutory preference for use of treatment + remedy is irreversible + no residual waste - MNA will not use treatment as means of reducing toxicity, mobility or volume

Criterion	Alternative 1: No Action	Alternative 2: MNA	Alternative 3: AS/SVE and MNA	Alternative 4: ISCO and MNA
<i>Short-Term Effectiveness</i>	1 - will not reach site closure + no added risk to the community, workers, or the environment resulting from implementation.	2 + no added risk to the community, workers, or the environment resulting from implementation. - expected to take ~40 years of MNA to reach cleanup criteria	3 + expected to take 3 years to reach MNA phase + minimal risks during implementation + volatilization is immediate upon interaction with air - secondary waste stream created - requires large amount of energy for ~3 years - expected to take ~30 years of MNA to reach cleanup criteria	4 + expected to take 1 year to reach MNA phase + oxidant is persistent in groundwater and will continue to perform until fully oxidized + treatment is immediate upon interaction with oxidant + no secondary waste stream created + requires minimal energy during implementation - implementation involves handling sodium permanganate and introducing it into aquifer - expected to take ~30 years of MNA to reach cleanup criteria
<i>Implementability</i>	5 + no issues with implementability <i>ICS</i>	5 + reliable technology + no issues with implementability - CEA and RAP required <i>Good client 2/2/3</i>	2 + reliable technology + contractors/supplies readily available - trenching and underground utilities or obstructions could make implementation difficult - requires 24/7 system - CEA, RAP, and air discharge permit required	4 + reliable technology + contractors/supplies readily available + no trenching required + no system required - CEA, RAP, and underground injection permit required
Total Score^a	10	22	22	28
Total Present Value^a	\$0	\$420,000	\$1,990,000	\$1,360,000

^a Total Score does not account for costs.

^b Cost is the total present value assuming a 7% discount rate for O&M activities and rounded to nearest \$10,000.

Ranking: 5= Excellent performance; 4 = Good/acceptable performance; 3= Average/acceptable performance; 2=Below average performance; 1= Unsatisfactory performance

4.4.2 IRP Site 6

Although Alternative 1, No Action, is the least costly and the most easily implementable alternative for impacted soils at IRP Site 6, this alternative does not meet the threshold criteria of protecting human health and the environment or complying with ARARs. These criteria must be met in order for an alternative to be considered feasible. Therefore, Alternative 1 cannot be considered as a viable alternative.

Alternative 2, Excavation and Disposal, meets the threshold criteria because it would be protective of human health and the environment by reducing concentrations of impacted soil at IRP Site 6 to cleanup criteria (chemical-specific ARARs).

Excavation and Disposal is easily implementable as well as technically and administratively feasible. All components necessary to complete excavation and disposal activities are readily available and proven technologies. This alternative will be effective in both the short-term and long-term as it is both a permanent and immediate remedy for the site. The contaminated waste from the site will be transferred to an offsite disposal facility, which is expected to treat the waste through a containment technology.

While Alternative 2 may have some short-term risks to remediation workers during the implementation, these risks will be mitigated through proper PPE and compliance with Occupational Safety and Health Act (OSHA) regulations.

This alternative will not meet the criteria of reducing toxicity, mobility, or volume of contaminants through treatment. However, due to the relatively small vertical and horizontal extents of contamination, treatment of soil was not considered to be practical or cost effective.

The total present value for Excavation and Disposal is estimated at \$60,000. **Table 4-6** summarizes this comparative analysis of Alternatives 1 and 2 for IRP Site 6.

Table 4-6. IRP Site 6 Summary of Comparative Analysis

Criterion		Alternative 1: No Action	Alternative 2: Excavation and Disposal
Threshold Criteria	<i>Overall Protection of Human Health and the Environment</i>	1 - Would not be protective.	5 + Would be protective through removal contaminants from site.
	<i>Compliance with ARARs</i>	1 - Would not comply with ARARs.	5 Would comply with ARARs immediately by removing impacted soil from site.
Primary Balancing Criteria	<i>Long-Term Effectiveness and Permanence</i>	1 - Would not be effective or permanent over the long-term.	4 + Would permanently remove contaminants from the Site. - Would transfer contaminants to disposal facility.
	<i>Reduction of Toxicity, Mobility, or Volume through Treatment</i>	1 - Would not provide treatment and thus toxicity, mobility or volume would not be reduced.	1 - Would not provide treatment and thus toxicity, mobility or volume would not be reduced.
	<i>Short-Term Effectiveness</i>	1 + No risk to the community, workers, or the environment resulting from implementation. - Will not achieve RAOs.	5 +/- Some potential risks to remediation workers during implementation which will be mitigated through proper PPE and conformance with OSHA standards. + RAOs would be achieved immediately upon implementation.
	<i>Implementability</i>	5 + Easily implemented.	4 + Easy to implement, no process requirements and not labor intensive, no O&M.
Total Score^a		10	24
Total Present Value^b		\$0	\$60,000

^a Total Score does not account for costs.

^b Cost is the total present value assuming a 7% discount rate for O&M activities.

Ranking: 5= Excellent performance; 4 = Good/acceptable performance; 3= Average/acceptable performance; 2=Below average performance; 1= Unsatisfactory performance

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were developed based on the findings presented in this FS and the 2011 RI Report (ANG, 2011).

- One groundwater monitoring event will be conducted at IRP Site 2 from piezometer 2PZ4 for laboratory analysis of DRO to confirm that concentrations in groundwater are continuing to decrease. If the results confirm the downward trend, then NFA status will be requested. If a downward trend is not confirmed, additional monitoring will be recommended.
- Alternative 4, ISCO and MNA, is the preferred alternative for remediating the PCE-impacted groundwater at IRP Site 3. This alternative will meet the RAOs of preventing further migration of contaminated groundwater and achieving site closure in approximately 30 years by actively treating PCE areas greater than 20 µg/l. This remedial alternative also protects human health and the environment, complies with ARARs, reduces toxicity, mobility, or volume through treatment and is the most cost effective alternative evaluated.
- Because the only remaining COCs at IRP Site 5 are VOCs associated with a former underground storage tank, regulatory oversight of IRP Site 5 has been transferred to the NJDEP and will be managed under the New Jersey Underground Storage Tank Rules and LSRP program.
- Alternative 2, Excavation and Disposal, is the preferred alternative for IRP Site 6 because it meets the RAOs and is protective of human health and the environment by reducing concentrations of impacted soil to below the cleanup criteria. This alternative is readily implementable as well as technically and administratively feasible. This remedial alternative complies with ARARs, is effective in both the short-term and long-term, and is cost effective.

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6.0 REFERENCES

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APPENDIX A
Project Correspondence

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Mackie, David (Somerset)

From: Defeo, Richard Capt USAF ANG 177 LRS/LGRS [richard.defeo@ang.af.mil]
Sent: Thursday, June 09, 2011 1:50 PM
To: Mackie, David (Somerset)
Subject: FW: :NJ Air National Guard- UST oversight issue- Site 5

Follow Up Flag: Follow up
Flag Status: Flagged

FYI

I suggest you read the entire chain below

-----Original Message-----

From: Atiya Wahab [mailto:Atiya.Wahab@dep.state.nj.us]
Sent: Thursday, June 09, 2011 1:42 PM
To: Roach.Bill@epamail.epa.gov
Cc: Defeo, Richard Capt USAF ANG 177 LRS/LGRS; Roman Luzecky
Subject: Re: :NJ Air National Guard- UST oversight issue- Site 5

Bill,
My management has just informed me that the former UST cleanup at Site 5 can be handled by an LSRP. Thanks, Atiya

>>> <Roach.Bill@epamail.epa.gov> 6/7/2011 1:59 PM >>>

Atiya, to clarify, the only site that the ANG is requesting to be taken out of CERCLA and moved to NJDEP oversight is Site 5. Regarding Site 5, the RI states that: "Residual gasoline petroleum constituents associated with the former UST are the remaining issue of environmental concern at the Site." Under those circumstances, EPA has allowed state oversight of residual gasoline petroleum constituents. Also, there is a CERCLA exclusion for petroleum constituents. Since it was listed as a Site in the Federal Facility Agreement, the ANG should carry Site 5 through the CERCLA process as a No Further Action with the understanding that the state will have regulatory oversight of the residual contamination. If your management is still not in favor of this change, let me know and I will check with our management. Thanks, Bill

From: "Atiya Wahab" <Atiya.Wahab@dep.state.nj.us>
To: Bill Roach/R2/USEPA/US@EPA
Cc: "Roman Luzecky" <Roman.Luzecky@dep.state.nj.us>
Date: 06/07/2011 01:03 PM
Subject: :NJ Air National Guard

Hi Bill,
With their most recent RIR submission dated 6/3/11, the NJ Air National Guard is requesting to be under the NJDEP's oversight and away from the USEPA oversight. Please let me know your decision regarding this request. Please be advised that the Department's management is not in favor of this proposed change.

Regards,

Atiya

Atiya Wahab
Case Manager, BCM, (5th Floor)
NJDEP
401 E. State St.

P.O. Box 420
Trenton, NJ 08625

Telephone: 609-633-2316
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atiya.wahab@dep.state.nj.us



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

JUN - 9 2011

Capt. Rich DeFeo
New Jersey Air National Guard
177th Fighter Wing
400 Langley Road
Egg Harbor, NJ 08234

Re.: Remedial Investigation Report for Air National Guard Sites 2, 3, 5, 6, June 2011
177th Fighter Wing, Egg Harbor Township, New Jersey

Dear Captain DeFeo,

EPA approves the above-referenced report with the exception of the following comments which will not require revisions of the document.

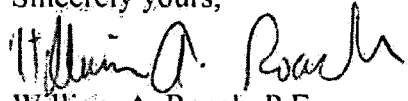
Comments

1. In the cover letter for the referenced report, it was requested that regulatory oversight of IRP Site 5 be transferred to the NJDEP and that it be closed as an IRP Site. EPA does not object to the transfer of regulatory oversight of Site 5 to NJDEP but it should not be officially closed as an IRP Site. In subsequent CERCLA documents such as the Feasibility Study, Proposed Plan and Record of Decision, Site 5 should be listed as No Further Action (NFA). It should also be clarified that regulatory oversight of Site 5 has been transferred to NJDEP and the justification for doing so. The reason for this is that Site 5 was listed as an Area of Concern (AOC) in the Federal Facility Agreement between FAA and EPA and was addressed in the Remedial Investigation (i.e.: it was not dropped from further consideration during the Preliminary Assessment/Site Investigation stage).

2. Off-site transfer of CERCLA waste requires approval by EPA that the receiving facility is appropriate for receiving such waste. This involves filling out a form detailing the nature and volume of waste, the name and location of the receiving facility and submitting it to EPA for approval. If you need a copy of the Off-Site Form, please contact this office.

If you have any questions regarding these comments, feel free to call me at (212) 637-4335.

Sincerely yours,

A handwritten signature in black ink, appearing to read "William A. Roach". The signature is fluid and cursive, with the first name "William" and last name "Roach" clearly distinguishable.

William A. Roach, P.E.
Federal Facilities Section

cc: A. Wahab, NJDEP
K. Buch, FAA

Gneiding, Laurie R

From: Mackie, David (Somerset)
Sent: Monday, January 17, 2011 2:40 PM
To: Gneiding, Laurie R
Subject: FW: NJANG Egg Harbor Twp, NJ - HHRA

-----Original Message-----

From: Smith.Lora@epamail.epa.gov [mailto:Smith.Lora@epamail.epa.gov]
Sent: Thursday, January 13, 2011 1:24 PM
To: Mackie, David (Somerset)
Cc: atiya.wahab@dep.state.nj.us; george.nicholas@dep.state.nj.us; Mullett, Jay J; jose.hurtado@us.af.mil; Kowalk, Kevin A; Sivak.Michael@epamail.epa.gov; rich.defeo@ang.af.mil; roach.william@epa.gov; tom.hupf@faa.gov; Odarchenko, Vladimir G
Subject: RE: NJANG Egg Harbor Twp, NJ - HHRA

Hi Dave,

I have reviewed your responses below and am in agreement with most. My comments are below in red.

Lora M. Smith, Ph.D.
U.S. Environmental Protection Agency, Region 2 Emergency and Remedial Response Division Superfund Program 290
Broadway, 18th Fl.
New York, N.Y. 10007

212.637.4299 (office)
212.637.3083 (fax)

From: "Mackie, David (Somerset)" <david.mackie@amec.com>
To: Lora Smith/R2/USEPA/US@EPA
Cc: "atiya.wahab@dep.state.nj.us" <atiya.wahab@dep.state.nj.us>, "george.nicholas@dep.state.nj.us" <george.nicholas@dep.state.nj.us>, "Mullett, Jay J" <Jay.Mullett@amec.com>, "jose.hurtado@us.af.mil" <jose.hurtado@us.af.mil>, "Kowalk, Kevin A" <Kevin.Kowalk@amec.com>, Michael Sivak/R2/USEPA/US@EPA, "rich.defeo@ang.af.mil" <rich.defeo@ang.af.mil>, "roach.william@epa.gov" <roach.william@epa.gov>, "tom.hupf@faa.gov" <tom.hupf@faa.gov>, "Odarchenko, Vladimir G" <vladimir.odarchenko@amec.com>, Michael Sivak/R2/USEPA/US@EPA

Date: 12/28/2010 04:14 PM
Subject: RE: NJANG Egg Harbor Twp, NJ - HHRA

Dr. Smith,

Thank you for your responses to our 17 September 2010 letter. To ensure that we are all in full concurrence regarding the content of the Final Remedial Investigation Report submittal, we are providing you with the following responses to each of the comments contained in your October 21 email (USEPA comments are shown in italics):

Potential Surface Water Impacts

1. EPA accepts this rationale. Please reference the report (s) which demonstrate that the groundwater plumes at Sites 3 and 5 have been delineated.

Response: The extent of the groundwater contaminant plume at Site 3 is described in Section 5.3 and illustrated in Figures 5-3 through 5-8 of the Draft Remedial Investigation Report (RIR) submittal. As noted in Section 2.3 of (page 8) of the Draft RIR, the extent of groundwater contaminants at Site 5 was delineated as part of the Expanded Supplemental Site Investigation (ESSI) conducted by TRC Environmental Corp, (TRC Environmental Corp, Expanded Supplemental Site Investigation Report, 177th Fighter Interceptor Group, NJANG, February 2003). This reference is already included with the Draft RIR.

Response: Thank you for providing the references.

2. EPA accepts this rationale

3. Please provide a table with NJDEP criteria, EPA RSLs, EPA MCLs and contaminant concentrations. EPA is in agreement if the table supports the argument (i.e.- the contaminant concentrations at Sites 3 and 5 do not exceed groundwater standards).

Response: Our letter did not state that contaminant concentrations do not exceed groundwater standards, but rather that the contaminant concentrations at both Sites "are less than 10 times the applicable NJDEP human-health based groundwater standards...". The point was to illustrate that the contaminant concentrations were generally very low and thus, not suggestive of the presence of non-aqueous phase liquid (NAPL).

A better method of assessing the potential for the presence of NAPL is to compare groundwater contaminant concentrations to their respective solubilities. As a general rule, the presence of NAPL is suspected when the concentration of the contaminant in groundwater exceeds 1% of the pure-phase solubility of the compound (please refer to page 5 of USEPA publication 9355.4-07FS <http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/estdnapl.pdf>).

At Site 3, the principal contaminant of concern is tetrachloroethene (PCE), of which the maximum concentration detected during the RI was 7.96 µg/L. The pure-phase solubility of PCE is approximately 200,000 µg/L (Applied Hydrogeology, C.W. Fetter, 1994, p. 468), so it can be concluded that the maximum detected PCE concentration was less than 0.004% of its solubility (i.e., three orders of magnitude below the threshold that would indicate the possible presence of DNAPL). Likewise, at Site 5, the maximum detected concentration of ethylbenzene (3.85 µg/L) was less than 0.003% of its solubility (150,000 µg/L), and the highest result reported for total xylenes was 7.23 µg/L, which was less than 0.005% of the solubility of m-xylene (146,000 µg/L, least soluble of the xylenes). Thus, all of the groundwater analytical results reported for volatile organic compounds during the RI were at least three orders of magnitude below the thresholds considered indicative of the presence of NAPL.

Response: I misread. Thank you for the clarification. This is not an acceptable line of evidence to suggest that the potential for contaminated groundwater to affect surface water bodies is not

likely. While concentrations do not suggest a NAPL, they are still above human-health based groundwater standards. Please omit this line of evidence. Lines of evidence proposed in #1, #2 and #5 are sufficient to support the argument.

4. Please omit. EPA does not accept this rationale. This sampling round consisted of only 3 surface water samples collected 14 years ago. Further, it contradicts the argument presented in #2 (if groundwater is moving very slowly from the Sites, we would not expect to see site-related contaminants in the surface water).

Response: This rationale will not be included in the report.

Response: Thank you.

5. EPA accepts this rationale.

6. Please omit. EPA does not accept this rationale. This is not a reason to not sample.

Response: This rationale will not be included in the report

Response: Thank you.

DRO Detected in Site 2 Groundwater

In the 3rd sentence, please omit "well below" as the maximum detected DRO concentration of 346 ug/L is not "well below" the NJDEP IGGWQC of 500 ug/L. EPA agrees that two samples do not constitute a trend; however, please omit "de minimis" in this sentence as this term does not appropriately describe the concentrations detected.

Response: The text in the final draft of the report will be edited as requested by the USEPA.

May we infer from your response that the agency agrees that further groundwater monitoring at Site 2 will not be required? (The response provided in your email does not specifically address this question.)

Response: EPA appreciates the aforementioned edits. EPA requests that one post-ROD confirmatory sample be collected. Monitoring will likely be a part of the remedy. EPA would like to confirm that concentrations of DRO in Site 2 groundwater decrease in time.

p-Isopropyltoluene in Site 5 Soils

EPA agrees with the fate and transport discussion. EPA agrees with the Regulatory Criteria rationale; however, please omit any reference to the Florida Department of Environmental Protection as this toxicity value is not applicable to a site in EPA Region 2. The oral reference dose from the ATSDR website referenced should be 0.1 mg/kg-day rather than 0.01 mg/kg-day. Please re-calculate RSLs (residential and non-residential) and update the table.

Response: The RSLs for p-isopropyltoluene were recalculated using the ATSDR RfDo of 0.1 mg/kg-day resulting in an RSL of 35,000 mg/kg for construction workers. Text was added in Section 8.2.1.1 indicating the derived worker RSL of 35,000 mg/kg, and the RSL for p-isopropyltoluene was modified in Table 8-1.

The following text was included in Section 8.2.2.4 – Environmental Fate & Transport of the Draft RI Report:

p-Isopropyltoluene Fate and Transport

Air: If released to air, p-isopropyltoluene (p-cymene) will exist solely as a vapor in the ambient atmosphere due to a vapor pressure of 1.5 mm Hg at 25°C. Vapor-phase p-cymene will degrade in the atmosphere by reacting with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be one day. In the dark, p-cymene will also be

degraded in the atmosphere by reaction with nighttime nitrate radicals; the half-life for this reaction is estimated to be 34 days.

Soil: If released to soil, p-cymene is expected to have slight mobility based upon an estimated log K_{oc} of 3.607. Volatilization from soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 0.011 atm-m³/mole. However, adsorption to soil is expected to attenuate volatilization. Screening biodegradation tests suggest that biodegradation in soil will be rapid.

Water: p-Cymene has been shown to biodegrade in activated sludges and in natural water systems. If released into water, it may adsorb to suspended solids and sediment based upon the estimated K_{oc} or volatilize from water surfaces based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are one hour and five days, respectively. Due to the potential for adsorption, volatilization rates are attenuated resulting in a volatilization half-life for a model pond of approximately 30 days. An estimated bio-concentration factor (BCF) of 286 suggests the potential for bioconcentration in aquatic organisms is high. Hydrolysis is not expected to be an important environmental fate process because p-cymene does not contain hydrolyzable functional groups. The results of screening biodegradation tests suggest that biodegradation in water is rapid.

The following text was added to Section 8.6.1.1, Bullet 1:

- Commercially, the compound is used as a starting material in the manufacture of fragrance ingredients and in consumer products such as: cosmetics, household and laundry cleaning products, and air freshener systems which are fragranced. It is also used as a solvent, and a chemical intermediate for the manufacture of p-cresol, thymol and other organic compounds.

The maximum concentration of 5.97 mg/kg was below an RSL of 35,000 mg/kg, derived using USEPA (2009c) equations and default exposure parameters for workers and an ATSDR (2005a) RfDo of 0.1 mg/kg-day.

The first bullet in Section 8.8.1 was modified as follows:

- Cymene (p-isopropyltoluene) was detected in soil at Sites 2 and 5; neither an RSL nor an NJDEP standard have been established for this compound by the regulatory agencies. An RSL of 35,000 mg/kg was derived for p-cymene, using an ATSDR RfDo of 0.1 mg/kg-day and USEPA default exposure parameters for construction workers. The reported concentrations (5.97 mg/kg, 0.433 mg/kg) are significantly less than the derived RSL; therefore, this compound was not carried through the HHRA.

Response: EPA approves of the above language.

Chromium Detected in Site 3 and Site 5 Groundwater

EPA would like to see the maximum chromium concentration run through the drinking water scenario as hexavalent chromium. Compare this value with the RSL and discuss in the uncertainty section. Since chromium is not known to be a site-related contaminant and maximum concentrations in soil are below the 95th percentile of background, this exercise should bolster the argument that hexavalent chromium is not the predominant form of chromium at the site.

Response: The following text has been added to the RI Report concerning chromium in groundwater

Section 7.3.3 – Chromium Speciation

An assessment of chromium speciation is possible when Eh and pH conditions in groundwater are known. Oxidation-reduction potential (ORP or Eh) is one of the factors that determines the valence state of chromium in ground water which, in turn, determines its relative toxicity. Previous groundwater sampling at Sites 3 and 5 included field Eh-pH measurements (performed as part of low-flow purging and sampling), which were evaluated in conjunction with the laboratory analytical results for total chromium. The Eh-pH results collected during two groundwater monitoring events at Sites 3 and 5 (during July and October 2006) (Table 7-4) were plotted on a stability field diagram and compared with the known stability fields of various dissolved chromium species (Figure 7-1). The data points form a tight cluster within the trivalent (Cr+3) stability field, which indicates that Eh-pH conditions in onsite groundwater favor the formation of Cr+3 over hexavalent chromium (Cr+6). Based on these empirical results, it is unlikely that the chromium detected in groundwater at Sites 3 and 5 is present in hexavalent form.

The following text was added to Section 8.8 – Uncertainty Analysis:

- Groundwater samples underwent chemical analyses for total metals. As described in Section 7.3.3, the likely valence state of chromium in groundwater was determined based on site-specific Eh-pH data, which was plotted on a stability field diagram (Figure 7-1). All of the Eh-pH results plotted within stability fields for trivalent chromium species. Therefore, it is unlikely that the chromium detected in groundwater at Sites 3 and 5 is present in hexavalent form.

In section 8.8.1, the second bullet, the following text was added:

Risk calculations were completed for both the trivalent and hexavalent chromium species in groundwater. Trivalent chromium is not considered carcinogenic; therefore, no risks were calculated. All trivalent chromium Hazard Indices (HIs) were less than the USEPA threshold of one.

Hexavalent chromium is considered carcinogenic; calculations resulted in risks greater than the USEPA threshold of 1×10^{-6} for ingestion and dermal contact for both adults and children (no inhalation risks were calculated given that chromium in water is neither volatile nor gives off particulates). HIs for hexavalent chromium were greater than one for ingestion (adults) and dermal contact (children). However, given that: a) There is no evidence of the historic use of hexavalent chromium compounds at either Site 3 or Site 5, b) The maximum concentration of total chromium detected in soil was below the 95th percentile of background reported by the NJDEP for urban New Jersey Coastal Plain Soils, and c) The results of site specific Eh-pH measurements plotted in Figure 7-1 fall entirely within the stability fields of trivalent chromium species, it is likely that the chromium detected in groundwater at the Sites 3 and 5 occurs predominantly in trivalent form. Therefore, as trivalent chromium is not carcinogenic and HIs are less than one, it is unlikely that the chromium detected in groundwater at Sites 3 and 5 poses a significant human health

risk.

Response: Did carcinogenic risks from hexavalent chromium associated with the ingestion and dermal contact with groundwater result in risks above the upper end of the risk threshold (1×10^{-4})? EPA does not have reason to believe that Cr6+ would be the predominant form of chromium at the site but we need a little more information to support this. Please provide more information regarding whether or not the maximum concentration falls within the acceptable risk range or information on the 95% UCL of the mean compared with human health screening levels.

We trust that these responses have fully addressed your remaining concerns. We would appreciate receiving your response as soon as possible, so we can proceed with the production and submittal of the Final Remedial Investigation Report. Please do not hesitate to contact me if you have any questions or concerns.

As always, we appreciate your assistance in helping us to move this project forward.

Sincerely,

David Mackie, P.G.
Senior Project Manager
AMEC Earth & Environmental, Inc.
285 Davidson Avenue, Suite 405
Somerset, New Jersey 08873
(732) 302-9500 x105
(732) 302-9504 (fax)

-----Original Message-----

From: Smith.Lora@epamail.epa.gov [mailto:Smith.Lora@epamail.epa.gov]

Sent: Thursday, October 21, 2010 2:44 PM

To: Mackie, David (Somerset)

Cc: atiya.wahab@dep.state.nj.us; george.nicholas@dep.state.nj.us; Mullett, Jay J; jose.hurtado@us.af.mil; Kowalk, Kevin A; Sivak.Michael@epamail.epa.gov; rich.defeo@ang.af.mil; roach.william@epa.gov; tom.hupf@faa.gov; Odarchenko, Vladimir G; Sivak.Michael@epamail.epa.gov

Subject: RE: NJANG Egg Harbor Twp, NJ - HHRA

Hi Dave,

EPA appreciates your effort in developing the lines of evidence document to address agency concerns. I have the following comments regarding this letter:

Potential Surface Water Impacts

1. EPA accepts this rationale. Please reference the report(s) which demonstrate that the groundwater plumes at Sites 3 and 5 have been delineated.
2. EPA accepts this rationale.
3. Please provide a table with NJDEP criteria, EPA RSLs, EPA MCLs and contaminant concentrations. EPA is in agreement if the table supports the argument (i.e.- the contaminant concentrations at Sites 3 and 5 do not exceed groundwater standards).
4. Please omit. EPA does not accept this rationale. This sampling round consisted of only 3 surface water samples collected 14 years ago.
Further, it contradicts the argument presented in #2 (if groundwater is moving very slowly from the Sites, we would not expect to see site-related contaminants in the surface water).
5. EPA accepts this rationale.
6. Please omit. EPA does not accept this rationale. This is not a reason to not sample.

DRO Detected in Site 2 Groundwater

In the 3rd sentence, please omit "well below" as the maximum detected DRO concentration of 346 ug/L is not "well below" the NJDEP IGGWQC of 500 ug/L. EPA agrees that two samples do not constitute a trend; however, please omit "de minimis" in this sentence as this term does not appropriately describe the concentrations detected.

p-Isopropyltoluene in Site 5 Soils

EPA agrees with the fate and transport discussion. EPA agrees with the Regulatory Criteria rationale; however, please omit any reference to the Florida Department of Environmental Protection as this toxicity value is not applicable to a site in



APPENDIX B

Summary Table of Detected Groundwater Analytical Data

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TABLE B-1
VOC Analytical Results - Geoprobe Groundwater Investigation at Site 3

New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, New Jersey

Sample ID	1,1-DCE	MTBE	trans-1,2-DCE	cis-1,2-DCE	benzene	TCE	toluene	PCE	ethyl-benzene	m- + p-xylenes	o-xylene	total xylenes
Shallow Zone [18'-30']												
B2 18-22 ft	0.9	0	0	0	0.08	0.11	0.17	2.5	0	0.98	0	-
B/C2 28 ft	0	0	0	0	0	0.24	0.16	48	0.09	0.27	0	-
B1 26 ft	0.38	0	0	0	0.097	0	0	8.9	0	0	0	-
B0/1 27 ft	0	0	0	0	0.11	0	0	0.017	0	0	0	-
F2(-12) 27 ft	0	0	0	0	0	0	0	0	0	0.19	0	-
B5 27 ft	0	0	0	0	0.1	0	0.15	0.8	0	0.15	0	-
C5 27 ft	0	0	0	0	0.25	0	0.12	0.18	0.51	0.43	0.35	-
C6 27 ft	0	0	0	0	0.088	0	0.26	0.73	0.15	0.59	0.22	-
A5 27 ft	0	0	0	0	0.096	0	0.26	0.018	0	0.063	0.12	-
C7 27 ft	0	0	0	0	0	0	0	0.3	0	0.093	0.16	-
D7 30 ft	0	0	0	0	0.071	0	0.083	1.3	0.066	0.24	0.15	-
I4/5 30 ft	0	0	0	0	0.044	0	0	0.01	0	0.17	0	-
I3(-5) 30 ft	0	0	0	0	0	0	0	0	0	0	0	-
G/H6(-21) 30 ft	0	1	0	0	0.053	0	0.13	0.036	0.056	0.24	0.086	-
G/H8(-21) 30 ft *	0	2.6	0 (ND)	0 (ND)	0 (ND)	0 (ND)	0.13 (ND)	0.051 (ND)	0 (ND)	0.088	0	(ND)
D8 30 ft	0	0	0	0	0	0	0.084	0.84	0	0.063	0.12	-
E8 30 ft	0	0.82	0	0	0	0.13	0.09	38	0	0.15	0	-
E9 30 ft	0	0	0	0.36	0	0.099	0	59	0	0.084	0.079	-
E14(-12) 27 ft	0	7.2	0	0	0.13	0	0.11	0.47	0	0.2	0.12	-
G/H 14/15 27 ft	0	20	0	0	0	0	0.11	0.033	0	0.11	0.095	-
E 10/11 27 ft	0	0	0	0	0	0	0.082	5	0.035	0.16	0.15	-
D 9/10 30 ft	0	0	0	0	0.62	0	0	0.22	0	0	0.094	-
G/H 10/11 (-21) 30 ft	0	0	0	0	0.11	0	0	0.071	0	0.63	0.84	-
E6 30 ft	0	0	0	0	0	0.16	0	22	0	0.099	0	-
E5 30 ft	0	0	0	0	0	0.37	0	14	0	0.1	0	-
G12/13(-15) 30 ft	0	5.8	0	0	0	0	0.054	4.9	0	0.1	0	-
D4(-20) 30 ft	0	0	0	0.092	0.15	0.34	0.11	13	0	0.11	0.18	-
I13/14(-10) 30 ft	0	0	0	0	0	0	0	0.057	0	0.038	0	-
F4/5 30 ft	0	0	0	0	0	0.15	0	1.2	0	0	0	-
I15 30 ft	0	0	0	0	0.081	0	0.11	0.02	0	2.4	6.1	-
J13/14 30 ft	0	0	0	0	0.16	0	0	0.067	0	0.21	0	-
J15(-12) 30 ft	0	0	0	0	0	0	0	0.053	0	0	0	-
I16 30 ft	0	0	0	0	0	0	0.2	0.04	0	0	0	-
A1/2 30 ft	0.75	0	0	0.61	0.61	0.38	0.13	0.54	0	0.096	0	-
Intermediate Zone [57'-80']												
B2 62 ft	1.2	0	0.52	0.22	0.54	0	0.33	0.052	0.2	0.42	0	-
B/C2 80 ft	0	0	0	0	0.097	0	0	0	0.096	0.32	0.091	-
B1 57 ft	0	0	0	0	0.095	0	0	0.027	0.087	0.44	0	-
F2(-12) 60 ft	0	0	0	0.15	0.22	0.28	0.14	0.018	0	0.2	0	-
B5 60 ft	0	0	0	0	0.2	0	0.29	0.008	0	0.31	0.14	-
C5 60 ft	0	0	0	0	0.14	0	0.15	21	0	0.34	0	-
C6 70 ft	0.35	0	0	0	0.14	0	0.23	0.005	0.053	0.22	0.14	-
C7 60 ft	0	0	0	0	0.095	0	0.13	0	0	0.13	0	-
D7 70 ft	0	0	0	0	0	0	0	0.008	0	0	0	-
I3(-5) 60 ft *	0	0	0 (ND)	0 (ND)	0 (ND)	0 (ND)	0 (ND)	0 (ND)	0 (ND)	0	0	(ND)
G/H6(-21) 60 ft	0	0.47	0	0	0.18	0	0.16	0.033	0	0.26	0	-
G/H8(-21) 60 ft	0	0.43	0	0	0.43	0	0.2	0.029	0.037	0.25	0.035	-
D8 70 ft	0	0	0	0	0.077	0	0.11	0.035	0	0.13	0	-
E8 70 ft	0	0	0	0.79	0.15	0.04	0	0.11	0.039	0.22	0.11	-
E9 70 ft	0	0	0	1.1	1.4	0	0.18	0.61	0.095	0.25	0.32	-
E14(-12) 60 ft	0	0	0	0	0.065	0	0.12	0.008	0	0.095	0.1	-
E 10/11 60 ft	0	0	0	0	0.15	0	0.14	0.056	0.039	0.13	0.063	-
G/H 10/11 (-21) 60 ft	0	0	0	0	0	0.38	0	0.009	0	0.18	0	-
E6 60 ft	0	0	0	0	0	0.14	0	0.058	0	0.061	0	-
G12/13(-15) 60 ft	0	0	0	0	0	0.62	0	0.062	0	0.055	0	-
D4(-20) 60 ft	0	0	0	0	0	0	0	0.15	0	0.036	0	-
I13/14(-10) 60 ft *	0	0	0 (ND)	0.26 (ND)	0 (ND)	2.2 (4.84)	0 (ND)	0.011 (ND)	0 (ND)	0.051	0	(ND)
I15 60 ft	0	0	0	0.29	0.19	1.7	0.15	0	0.29	0.43	0	-
J13/14 60 ft	0	0	0	0.35	1.2	0	0.11	0	0	0.27	0	-
J15(-12) 60 ft	0	0	0	0.32	0.21	0.36	0	0.012	0	0	0	-
I16 60 ft *	0	0	0 (ND)	0.21 (ND)	0 (ND)	0.9 (3.80)	0.18 (ND)	0 (ND)	0	0	0.12	(ND)
Deep Zone [96'-110']												
B2 110 ft *	0.88	0	0 (ND)	0.17 (ND)	0.58 (0.380)	0 (ND)	0.46 (1.19)	0.066 (ND)	0 (ND)	0	0	(1.93)
B/C2 100 ft	0	0	0	0	1.3	0	0.49	0	0.15	0.43	0.26	-
B5 105 ft	1.1	0	0	0.33	1.2	0.52	0.5	0.01	0.14	0.58	0.25	-
C5 98 ft	1.3	0	0	0	5	0	0.6	0.08	1	0.89	0.53	-
C6 102 ft *	0.58	0	0 (ND)	0 (ND)	0.66 (ND)	0 (ND)	0.45 (0.950J)	0.009 (ND)	0.084	0.26	0.3	(ND)
A5 100 ft	0.56	0	0	0.13	0.63	0	0.75	0	0.039	0.11	0	-
I4/5 105 ft	0	0	0	0.35	0.49	0.73	0	0.009	0	0.35	0	-
G/H 14/15 103 ft	0.64	0	0	0.21	1.1	0.27	0.16	0.014	0.039	0.16	0.13	-
G/H 10/11 (-21) 97 ft *	0	0	0 (ND)	0 (ND)	0.2 (ND)	0.58 (1.25)	0 (ND)	0.008 (ND)	0 (ND)	0.15	0	(ND)
E5 102 ft	0	0	0	0	0.09	0.41	0.075	0.12	0	0	0.16	-
I13/14(-10) 103 ft	0.68	0	0	0.26	0.52	0.48	0.057	0.012	0	0	0	-
I15 96 ft	0.83	0	0	0.33	0.47	1	0	0	0	0.26	0	-

* Confirmation samples collected at a rate of one for every 10 samples submitted for field analysis. Confirmation samples were submitted to Test America Laboratory and were analyzed for BTEX, 1,2 DCE, TCE and PCE. Results are presented on this Table in parenthesis and colored blue next to the corresponding field analyzed concentration.
All results reported in µg/L.

TABLE B-2

VOC Analytical Results - Groundwater Monitoring Wells at Site 3
New Jersey Air National Guard, 177th Fighter Wing
Egg Harbor Township, New Jersey

NJDEP PQL* (ug/L)	Field Sample ID	3MW101-01	3MW101-02	3MW201-01	3MW201-02	3MW301-01	3MW301-02	3MW302-01
	Laboratory Sample ID	NPG3165-03	NPJ4110-05	NPG3165-02	NPJ4110-02	NPG3590-03	NPK0267-03	NPG3386-03
	Sampling Date	7/25/2006	10/30/2006	7/25/2006	10/30/2006	7/27/2006	11/1/2006	7/26/2006
10	Acetone	ND	ND	ND	ND	ND	ND	ND
1	Benzene	ND	ND	ND	ND	ND	ND	ND
NA	Bromobenzene	ND	ND	ND	ND	ND	ND	ND
NA	Bromochloromethane	ND	ND	ND	ND	ND	ND	ND
1	Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND
0.8	Bromoform	ND	ND	ND	ND	ND	ND	ND
1	Bromomethane	ND	ND	ND	ND	ND	ND	ND
2	2-Butanone (MEK)	<3.06	<2.76	<3.06	<2.76	ND	<2.70	ND
NA	sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Carbon Disulfide	ND	ND	ND	ND	ND	ND	ND
1	Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND
1	Chlorobenzene	ND	ND	ND	ND	ND	ND	ND
1	Chlorodibromomethane	<0.48	ND	<0.48	ND	ND	ND	ND
0.5	Chloroethane	ND	ND	ND	ND	ND	ND	ND
1	Chloroform	ND	ND	ND	ND	ND	ND	ND
2	Chloromethane	ND	ND	ND	ND	ND	ND	ND
NA	2-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND
NA	4-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND
0.02	1,2-Dibromo-3-chloropropane	<0.69	<0.88	<0.69	<0.88	<0.62	<0.46	<0.62
0.03	1,2-Dibromoethane	<0.14	<0.14	<0.14	<0.14	<0.11	<0.20	<0.11
NA	Dibromomethane	ND	ND	ND	ND	ND	ND	ND
5	1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
5	1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
5	1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2	Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND
1	1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
2	1,2-Dichloroethane	ND	ND	ND	ND	ND	<0.460	ND
1	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	trans-1, 2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	1,3-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
1	1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
NA	2,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
1	cis-1, 3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
1	trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
NA	1,1-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
2	Ethylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND
2	2-Hexanone	ND	ND	ND	ND	ND	ND	ND
1	Isopropylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	p-Isopropyltoluene	ND	ND	ND	ND	ND	ND	ND
1	Methyl tert-butyl ether	ND	ND	ND	ND	ND	ND	ND
1	Methylene Chloride	ND	ND	ND	ND	ND	ND	ND
NA	4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND
2	Naphthalene	ND	ND	ND	ND	ND	ND	ND
NA	n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND
2	Styrene	ND	ND	ND	ND	ND	ND	ND
1	1,1,1,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1	1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1	Tetrachloroethene	2.63	1.28	ND	0.43 J	0.67 J	ND	ND
1	Toluene	ND	ND	ND	ND	ND	ND	ND
NA	1,2,3-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2	1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1	Trichloroethene	0.67 J	0.39 J	ND	ND	ND	ND	ND
1	Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND
0.03	1,2,3-Trichloropropane	<0.38	<0.10	<0.38	<0.10	<0.13	<0.10	<0.13
NA	1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Vinyl Chloride	<0.19	ND	<0.19	ND	ND	<0.15	ND
2	Xylenes	ND	ND	ND	ND	ND	ND	ND

notes:

*New Jersey Department of Environmental Protection
(NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C,
revised November 4, 2009.

Results exceeding the PQL's are shown in **bold** type.

ND - Not detected.

NA - Not applicable or not established.

J - Estimated value

NR - Not reported

U - Data Validation qualified reported concentration as non-detect (ND)

< - Non-detected paramaters for which the Method detection limit (MDL) was than the
corresponding PQL are shown as less than "<" the MDL.

TABLE B-2

VOC Analytical Results - Groundwater Monitoring Wells at Site 3
New Jersey Air National Guard, 177th Fighter Wing
Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	Field Sample ID	3MW302-02	3MW303-01	3MW303-02	3MW401-01	3MW401-02	3MW402-01	3MW402-02
	Laboratory Sample ID	NPK0071-03	NPG3590-06	NPK0431-01	NPG3165-01	NPJ4110-01	NPG3386-02	NPK0071-01
	Sampling Date	10/31/2006	7/27/2006	11/2/2006	7/25/2006	10/30/2006	7/26/2006	10/31/2006
10	Acetone	ND	ND	ND	ND	ND	ND	ND
1	Benzene	ND	ND	ND	ND	ND	ND	ND
NA	Bromobenzene	ND	ND	ND	ND	ND	ND	ND
NA	Bromochloromethane	ND	ND	ND	ND	ND	ND	ND
1	Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND
0.8	Bromoform	ND	ND	ND	ND	ND	ND	ND
1	Bromomethane	ND	ND	ND	ND	ND	ND	ND
2	2-Butanone (MEK)	<2.91	ND	ND	<2.70	<2.76	ND	<2.91
NA	sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Carbon Disulfide	ND	ND	ND	ND	ND	ND	ND
1	Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND
1	Chlorobenzene	ND	ND	ND	ND	ND	ND	ND
1	Chlorodibromomethane	ND	ND	ND	ND	ND	ND	ND
0.5	Chloroethane	ND	ND	ND	ND	ND	ND	ND
1	Chloroform	ND	ND	ND	ND	ND	ND	ND
2	Chloromethane	ND	ND	ND	ND	ND	ND	ND
NA	2-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND
NA	4-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND
0.02	1,2-Dibromo-3-chloropropane	<0.60	<0.62	<0.21	<0.46	<0.88	<0.62	<0.60
0.03	1,2-Dibromoethane	<0.13	<0.11	<0.09	<0.20	<0.14	<0.11	<0.13
NA	Dibromomethane	ND	ND	ND	ND	ND	ND	ND
5	1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
5	1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
5	1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2	Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND
1	1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
2	1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
1	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	trans-1, 2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	1,3-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
1	1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
NA	2,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
1	cis-1, 3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
1	trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
NA	1,1-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
2	Ethylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND
2	2-Hexanone	ND	ND	ND	ND	ND	ND	ND
1	Isopropylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	p-Isopropyltoluene	ND	ND	ND	ND	ND	ND	ND
1	Methyl tert-butyl ether	ND	ND	ND	ND	ND	ND	ND
1	Methylene Chloride	ND	ND	ND	ND	ND	ND	ND
NA	4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND
2	Naphthalene	ND	ND	ND	ND	ND	ND	ND
NA	n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND
2	Styrene	ND	ND	ND	ND	ND	ND	ND
1	1,1,1,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1	1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1	Tetrachloroethene	ND	7.96	7.36	ND	0.4 J	2.86	0.9 J
1	Toluene	ND	ND	ND	ND U	ND	0.047 J	ND
NA	1,2,3-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2	1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1	Trichloroethene	ND	ND	ND	0.81 J	ND	ND	ND
1	Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND
0.03	1,2,3-Trichloropropane	<0.16	<0.13	<0.12	<0.10	<0.10	<0.13	<0.16
NA	1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Vinyl Chloride	<0.14	ND	<0.20	<0.15	ND	ND	<0.14
2	Xylenes	ND	ND	ND	ND	ND	ND U	ND

notes:
*New Jersey Department of Environmental Protection
(NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C,
revised November 4, 2009.
Results exceeding the PQL's are shown in **bold** type.
ND - Not detected.
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J - Estimated value
NR - Not reported
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corresponding PQL are shown as less than "<" the MDL.

TABLE B-2

VOC Analytical Results - Groundwater Monitoring Wells at Site 3
New Jersey Air National Guard, 177th Fighter Wing
Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	Field Sample ID	3MW402D-01	3MW402D-02	3MW403-01	3MW403-02	3MW404D-01	3MW404D-02	3MW405-01
	Laboratory Sample ID	NPG3386-01	NPK0071-02	NPG3386-06	NPK0267-04	NPG3590-07	NPK0431-02	NPG3386-04
	Sampling Date	7/26/2006	10/31/2006	7/26/2006	11/1/2006	7/27/2006	11/2/2006	7/26/2006
10	Acetone	ND	ND	ND	ND	ND	ND	ND
1	Benzene	ND	ND	ND	ND	ND	ND	ND
NA	Bromobenzene	ND	ND	ND	ND	ND	ND	ND
NA	Bromochloromethane	ND	ND	ND	ND	ND	ND	ND
1	Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND
0.8	Bromoform	ND	ND	ND	ND	ND	ND	ND
1	Bromomethane	ND	ND	ND	ND	ND	ND	ND
2	2-Butanone (MEK)	ND	<2.91	ND	<2.70	ND	ND	ND
NA	sec-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	tert-Butylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Carbon Disulfide	ND	ND	ND	ND	ND	ND	ND
1	Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND
1	Chlorobenzene	ND	ND	ND	ND	ND	ND	ND
1	Chlorodibromomethane	ND	ND	ND	ND	ND	ND	ND
0.5	Chloroethane	ND	ND	ND	ND	ND	ND	ND
1	Chloroform	ND	1.86	ND	ND	ND U	ND	ND U
2	Chloromethane	ND	ND	ND	ND	ND	ND	ND
NA	2-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND
NA	4-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND
0.02	1,2-Dibromo-3-chloropropane	<0.62	<0.60	<0.62	<0.46	<0.62	<0.21	<0.62
0.03	1,2-Dibromoethane	<0.11	<0.13	<0.11	<0.20	<0.11	<0.09	<0.11
NA	Dibromomethane	ND	ND	ND	ND	ND	ND	ND
5	1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
5	1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
5	1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2	Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND
1	1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
2	1,2-Dichloroethane	ND	ND	ND	<0.460	ND	ND	ND
1	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	trans-1, 2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1	1,3-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
1	1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
NA	2,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
1	cis-1, 3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
1	trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
NA	1,1-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
2	Ethylbenzene	ND	ND	ND	ND	ND	ND	ND
1	Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND
2	2-Hexanone	ND	ND	ND	ND	ND	ND	ND
1	Isopropylbenzene	ND	ND	ND	ND	ND	ND	ND
NA	p-Isopropyltoluene	ND	ND	ND	ND	ND	ND	ND
1	Methyl tert-butyl ether	ND	ND	ND	ND	ND	ND	ND
1	Methylene Chloride	ND	ND	ND	ND	ND	ND	ND
NA	4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND
2	Naphthalene	ND	ND	ND	ND	ND	ND	3.67 J
NA	n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND
2	Styrene	ND	ND	ND	ND	ND	ND	ND
1	1,1,1,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1	1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1	Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND
1	Toluene	ND U	ND	ND	ND	ND	ND	ND
NA	1,2,3-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2	1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1	1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1	Trichloroethene	ND	ND	ND	ND	ND	ND	ND
1	Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND
0.03	1,2,3-Trichloropropane	<0.13	<0.16	<0.13	<0.10	<0.13	<0.12	<0.13
NA	1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	0.96 J
NA	1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	1.96
1	Vinyl Chloride	ND	<0.14	ND	<0.15	ND	<0.20	ND
2	Xylenes	ND U	ND	ND	ND	ND	ND	5.01

notes:
*New Jersey Department of Environmental Protection
(NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C,
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TABLE B-2

VOC Analytical Results - Groundwater Monitoring Wells at Site 3
New Jersey Air National Guard, 177th Fighter Wing
Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	Field Sample ID	3MW405-02	3MW406-01	3MW406-02	3MW406D-01	3MW406D-02
	Laboratory Sample ID	NPK0071-06	NPG3590-02	NPK0071-07	NPG3590-01	NPK0267-05
	Sampling Date	10/31/2006	7/27/2006	10/31/2006	7/27/2006	11/1/2006
10	Acetone	ND	ND	ND	ND	ND
1	Benzene	ND	ND	ND	ND	ND
NA	Bromobenzene	ND	ND	ND	ND	ND
NA	Bromochloromethane	ND	ND	ND	ND	ND
1	Bromodichloromethane	ND	ND	ND	ND	ND
0.8	Bromoform	ND	ND	ND	ND	ND
1	Bromomethane	ND	ND	ND	ND	ND
2	2-Butanone (MEK)	<2.91	ND	<2.91	ND	<2.70
NA	sec-Butylbenzene	ND	ND	ND	ND	ND
NA	n-Butylbenzene	ND	ND	ND	ND	ND
NA	tert-Butybenzene	ND	ND	ND	ND	ND
1	Carbon Disulfide	ND	ND	ND	ND	ND
1	Carbon tetrachloride	ND	ND	ND	ND	ND
1	Chlorobenzene	ND	ND	ND	ND	ND
1	Chlorodibromomethane	ND	ND	ND	ND	ND
0.5	Chloroethane	ND	ND	ND	ND	ND
1	Chloroform	ND	ND	ND	ND U	1.36
2	Chloromethane	ND	ND	ND	ND	ND
NA	2-Chlorotoluene	ND	ND	ND	ND	ND
NA	4-Chlorotoluene	ND	ND	ND	ND	ND
0.02	1,2-Dibromo-3-chloropropane	<0.60	<0.62	<0.60	<0.62	<0.46
0.03	1,2-Dibromoethane	<0.13	<0.11	<0.13	<0.11	<0.20
NA	Dibromomethane	ND	ND	ND	ND	ND
5	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
5	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
2	Dichlorodifluoromethane	ND	ND	ND	ND	ND
1	1,1-Dichloroethane	ND	ND	ND	ND	ND
2	1,2-Dichloroethane	ND	ND	ND	ND	<0.460
1	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND
1	1,1-Dichloroethene	ND	ND	ND	ND	ND
1	trans-1, 2-Dichloroethene	ND	ND	ND	ND	ND
1	1,3-Dichloropropane	ND	ND	ND	ND	ND
1	1,2-Dichloropropane	ND	ND	ND	ND	ND
NA	2,2-Dichloropropane	ND	ND	ND	ND	ND
1	cis-1, 3-Dichloropropene	ND	ND	ND	ND	ND
1	trans-1,3-Dichloropropene	ND	ND	ND	ND	ND
NA	1,1-Dichloropropene	ND	ND	ND	ND	ND
2	Ethylbenzene	0.61 J	ND	ND	ND	ND
1	Hexachlorobutadiene	ND	ND	ND	ND	ND
2	2-Hexanone	ND	ND	ND	ND	ND
1	Isopropylbenzene	ND	ND	ND	ND	ND
NA	p-Isopropyltoluene	ND	ND	ND	ND	ND
1	Methyl tert-butyl ether	ND	ND	ND	ND	ND
1	Methylene Chloride	ND	ND	ND	ND	ND
NA	4-Methyl-2-pentanone	ND	ND	ND	ND	ND
2	Naphthalene	3.36 J	ND	ND	ND	ND
NA	n-Propylbenzene	ND	ND	ND	ND	ND
2	Styrene	ND	ND	ND	ND	ND
1	1,1,1,2-Tetrachloroethane	ND	ND	ND	ND	ND
1	1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND
1	Tetrachloroethene	ND	ND	ND	ND	ND
1	Toluene	ND	ND	ND	ND	ND
NA	1,2,3-Trichlorobenzene	ND	ND	ND	ND	ND
1	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
2	1,1,2-Trichloroethane	ND	ND	ND	ND	ND
1	1,1,1-Trichloroethane	ND	ND	ND	ND	ND
1	Trichloroethene	ND	ND	ND	ND	ND
1	Trichlorofluoromethane	ND	ND	ND	ND	ND
0.03	1,2,3-Trichloropropane	<0.16	<0.13	<0.16	<0.13	<0.10
NA	1,3,5-Trimethylbenzene	0.77 J	ND	ND	ND	ND
NA	1,2,4-Trimethylbenzene	1.61	ND	ND	ND	ND
1	Vinyl Chloride	<0.14	ND	<0.14	ND	<0.15
2	Xylenes	3.88	ND	ND	ND	ND

notes:
*New Jersey Department of Environmental Protection
(NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C,
revised November 4, 2009.
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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	FAA Facility Wide Background Range (µg/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID	3MW101-01		3MW101-02		3MW201-01	
						NPG3165-03		NPJ4110-02		NPG3165-02	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date Filtered / Unfiltered	7/25/2006		10/30/2006		7/25/2006	
						Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	71.1 J	226	127	157	<40.0	91.8 J
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.6	<4.6	<4.8	<4.8	<4.6	<4.6
200	NR	NR	NR	NR	Barium	36.9	53.5	53.4	54.9	17.6	20.1
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	ND	ND	ND	ND	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.5	<5.1	<1.3	<1.3	<1.5	1.6 J
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	<43.0	<43.0	<43.0	<43.0	156
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	2.7 J	ND	ND	ND
NA	NR	NR	NR	NR	Magnesium	2,410	2,810	2,500	2,380	7,170	7,880
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	14.9 J	28.8	NR	28.7	<5.0	123
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	9,300	NR	NR	8,290	7,670	NR
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

Results exceeding the PQL's are shown in **bold** type.

ND - Not detected.

NA - Not applicable or not established.

J - Estimated value

NR - Not reported

Concentrati

U - Data Validation qualified reported concentration as non-detect (ND)

< - Non-detected parameters for which the Method detection limit (MDL) was less than the corresponding PQL are shown as less than "<" the MDL.

TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	FAA Facility Wide Background Range (µg/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID	3MW201-02		3MW301-01		3MW301-02	
						NPJ4110-02		NPG3590-03		NPK0267-03	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date Filtered / Unfiltered	10/30/2006		7/27/2006		11/1/2006	
						Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	<40.0	73.2 J	161	280	174	283
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.8	<4.8	<4.6	<4.6	<4.8	<4.8
200	NR	NR	NR	NR	Barium	21.3	23.1	188	166	117	130
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	ND	0.4 J	0.6 J	ND	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.3	1.7 J	<1.5	ND U	<1.3	<1.3
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	151	55.2	98.7	<43.0	56.2
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	ND	ND	ND	ND
NA	NR	NR	NR	NR	Magnesium	7,980	8,440	5,150	4,400	3,340	3,470
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	NR	45	NR	NR	NR	21.8
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	NR	9,110	NR	NR	NR	5,230
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

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J - Estimated value

NR - Not reported

Concentrati

U - Data Validation qualified reported concentration as non-detect (ND)

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	FAA Facility Wide Background Range (µg/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID	3MW302-01		3MW302-02		3MW303-01	
					Laboratory ID	NPG3386-03		NPK0071-03		NPG3590-06	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date	7/26/2006		10/31/2006		7/27/2006	
					Filtered / Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	140	549	78.7 J	148	<40.0	705
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	4.8 J	<4.6	<4.8	<4.8	<4.6	<4.6
200	NR	NR	NR	NR	Barium	56.6	73	54.7	57.1	35.3	41.1
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	0.8 J	2	0.5 J	ND	ND	0.4 J
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.5	2.3 J	<1.3	2.1 J	<1.5	ND U
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	712	<43.0	94.7	<43.0	723
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	ND	ND	ND	ND
NA	NR	NR	NR	NR	Magnesium	1,340	1,350	1,390	1,380	2,870	3,200
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	87.9	91.6	NR	92.4	NR	NR
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	1,550	1,700	NR	1,730	NR	NR
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

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Concentrati

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	FAA Facility Wide Background Range (µg/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID	3MW303-02		3MW401-01		3MW401-02	
						NPK0431-01		NPG3165-01		NPJ4110-01	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date Filtered / Unfiltered	11/2/2006		7/25/2006		10/31/2006	
						Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	<40.0	334	190	381	225	290
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.8	<4.8	<4.6	<4.6	<4.8	<4.8
200	NR	NR	NR	NR	Barium	42.1	42.4	152	159	143	149
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	0.8 J	ND	ND	ND	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.3	2.7 J	<1.5	4.6 J	<1.3	2.8 J
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	386	321	808	<43.0	151
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	ND	20.4	ND	ND
NA	NR	NR	NR	NR	Magnesium	2,910	2,580	3,780	4,090	3,890	3,890
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	<5.0	5.7 J	253	274	NR	305
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	5,450	5,600	6,530	NR	NR	8,500
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

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Concentrati

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	FAA Facility Wide Background Range (µg/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID	3MW402-01		3MW402-02		3MW402D-01	
					Laboratory ID	NPG3386-02		NPK0071-01		NPG3386-01	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date	7/26/2006		10/31/2006		7/29/2006	
					Filtered / Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	85.9 J	81.3 J	113	240	45.5 J	106
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.6	<4.6	<4.8	<4.8	<4.6	<4.6
200	NR	NR	NR	NR	Barium	81.2	86.2	80.4	83.2	131	138
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	ND	ND	ND	0.4 J	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.5	<1.5	<1.3	1.6 J	<1.5	<1.5
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	<43.0	<43.0	128	<43.0	200
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	2.4 J	ND	ND	ND
NA	NR	NR	NR	NR	Magnesium	2,160	2,200	2,390	2,300	2,700	2,780
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	44.7	46.2	NR	46.3	28.3	30.1
4	1 - 5.7	NR	NR	NR	Selenium	11.9 J	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	6,120	7,110	NR	7,930	11,500	13,000
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

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Concentrati

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (ug/L)	FAA Facility Wide Background Range (ug/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID	3MW402D-02		3MW403-01		3MW403-02	
						NPK0071-02		NPG3386-06		NPK0267-04	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date Filtered / Unfiltered	10/31/2006		7/26/2006		11/1/2006	
						Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	<40.0	69.9 J	413	483	383	543
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.8	<4.8	<4.6	<4.6	<4.8	<4.8
200	NR	NR	NR	NR	Barium	168	158	94.5	101	84.5	89.8
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	ND	ND	ND	ND	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.3	2.0 J	<1.5	2.7 J	<1.3	4.5 J
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	<43.0	<43.0	97.5	<43.0	155
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	ND	ND	2.6 J	ND
NA	NR	NR	NR	NR	Magnesium	2,770	2,680	2,240	2,300	2,350	2,350
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	NR	17	5.4 J	5.4 J	NR	<5.0
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	NR	13,000	6,870	8,080	NR	8,460
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (ug/L)	FAA Facility Wide Background Range (ug/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID	3MW404D-01		3MW404D-02		3MW405-01	
						NPG3590-07		NPK0431-02		NPG3386-04	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date Filtered / Unfiltered	7/27/2006		11/2/2006		7/26/2006	
						Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	48.8 J	59.2 J	<40.0	495	222	264
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.6	<4.6	<4.8	<4.8	<4.6	<4.6
200	NR	NR	NR	NR	Barium	57.4	55.9	64.7	66.7	130	140
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	ND	ND	ND	ND	0.7 J
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.3	ND U	<1.3	0.6 J	<1.5	1.6 J
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	<43.0	<43.0	430	<43.0	104
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND U	ND	ND	2.3 J	ND	ND
NA	NR	NR	NR	NR	Magnesium	1,660	1,580	1,670	1,480	3,480	3,610
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	NR	NR	8.7 J	9.4 J	108	114
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	NR	NR	6,150	6,140	6,790	8,080
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

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Concentrati

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (ug/L)	FAA Facility Wide Background Range (ug/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID	3MW405-02		3MW406-01		3MW406-02	
						NPK0071-06		NPG3590-02		NPK0071-07	
		Undeveloped (n=15)	Agricultural (n=30)	Urban (n=30)	Date Filtered / Unfiltered	10/31/2006		7/27/2006		10/31/2006	
						Filtered	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	235	296	666	722	634	862
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.8	<4.8	8.8 J	<4.6	<4.8	<4.8
200	NR	NR	NR	NR	Barium	139	150	68.8	67.9	63.6	70.7
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	0.4 J	ND	ND	ND	ND	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.3	<1.3	<1.5	ND U	<1.3	1.9 J
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	<43.0	<43.0	124	<43.0	142
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	ND	ND	ND	ND
NA	NR	NR	NR	NR	Magnesium	3,850	3,920	3,470	3,340	3,120	3,300
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	NR	107	NR	NR	NR	9.6 J
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	NR	8,630	NR	NR	NR	4,630
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	0.242

notes:

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TABLE B-3

Metals Analytical Results - Groundwater Monitoring Wells at Site 3 (ug/L)
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJDEP PQL* (µg/L)	FAA Facility Wide Background Range (µg/L) (TRC, 1988)	Ambient Groundwater Monitoring Results for New Jersey Coastal Plain (NJGS, 2007)			Sample ID Laboratory ID Date Filtered / Unfiltered	3MW406D-01		3MW406D-02	
						NPG3590-01		NPK0267-02	
		Undeveloped (n=15)	Agriculatural (n=30)	Urban (n=30)		7/27/2006		11/1/2006	
						Filtered	Unfiltered	Filtered	Unfiltered
30	NR	3.6 - 1,900	3 - 10,000	2.0 - 5,000	Aluminum	<40.0	140	<40.0	67.3 J
3	<10	0.7 - 2.2	0.1 - 0.26	0.08 - 110	Arsenic	<4.6	<4.6	<4.8	<4.8
200	NR	NR	NR	NR	Barium	49.4	49.4	49.2	52
0.5	2 - 17.3	0.02 - 1.0	0.04 - 15.0	0.04 - 10.0	Cadmium	ND	ND	ND	ND
1	3.1 - 44.8	NR	NR	NR	Chromium (Total)	<1.5	ND U	<1.3	<1.3
20	NR	8.0 - 50,000	4.0 - 21,000	5.0 - 60,000	Iron	<43.0	194	<43.0	<43.0
5	1 - 51.5	0.1 - 1.2	0.06 - 10	0.06 - 12	Lead	ND	ND	2.5 J	ND
NA	NR	NR	NR	NR	Magnesium	1,550	1,480	1,500	1,470
0.4	NR	2.0 - 2,200	4.0 - 900	0.22 - 1,000	Manganese	NR	NR	NR	9.1 J
4	1 - 5.7	NR	NR	NR	Selenium	<8.2	<8.2	<8.2	<8.2
1	2.5 - 8.7	NR	NR	NR	Silver	<1.9	<1.9	<1.9	<1.9
400	NR	NR	NR	NR	Sodium	NR	NR	NR	5,060
0.05	0.05 - 2.9	NR	NR	NR	Mercury	<0.1	<0.1	<0.1	<0.1

notes:

*New Jersey Department of Environmental Protection (NJDEP) Ground Water Quality Standards, N.J.A.C. 7:9C, revised November 4, 2009.

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TABLE B-4
Natural Attenuation Analytical Results - Groundwater Monitoring Wells at Site 3

New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, New Jersey

		Sample ID	3MW101-01	3MW101-02	3MW201-01	3MW201-02	3MW301-01	3MW301-02
		Laboratory ID	NPG3165-03	NPJ4110-05	NPG3165-02	NPJ4110-02	NPG3590-03	NPK0267-03
		Date	7/25/2006	10/30/2006	7/25/2006	10/30/2006	7/27/2006	11/1/2006
		Matrix	Water	Water	Water	Water	Water	Water
Analyte	Units							
Alkalinity	mg/L		32.2	22.8	94	100	8.6 J	ND
Nitrate	mg/L		2.39	1.88	1.1	0.808	9.58	6.94
Sulfate	mg/L		16.6	18.4	4.99	5.86	ND	ND B
Methane	ug/L		ND	ND	ND	ND	ND	ND
Total Organic Carbon	mg/L		ND	ND	0.588 J	ND	ND	ND
pH ¹	NA		5.2	5.45	6.01	6.4	5.07	4.9
Dissolved Oxygen (DO) ¹	mg/L		5.47	6	6.1	6.68	6.97	6.19
Oxygen Reduction Potential (ORP) ¹	Mv		257	258	168	133	286	306
Ferrous Iron ²	mg/L		0.0	0.0	0.1	0.1	0.2	0.0

¹ pH, DO and ORP readings measured in the field during sampling
with a Horiba U-22 Water Quality Meter.

Readings shown represent last stabilized reading prior to collection of sample.

² Ferrous iron measured in the field using a Hach Dissolved Iron test kit.

ND = Not Detected above laboratory method detection limits (MDLs)

NA = No standard established for this analyte

B = Detected, however was qualified as non-detect due to
analyte being detected in blank sample

J = Estimated Value

TABLE B-4
Natural Attenuation Analytical Results - Groundwater Monitoring Wells at Site 3

**New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, New Jersey**

		Sample ID	3MW302-01	3MW302-02	3MW303-01	3MW303-02	3MW401-01	3MW401-02
		Laboratory ID	NPG3386-03	NPK0071-03	NPG3590-06	NPK0431-01	NPG3165-01	NPJ4110-01
		Date	7/26/2006	10/31/2006	7/27/2006	11/2/2006	7/25/2006	10/30/2006
		Matrix	Water	Water	Water	Water	Water	Water
Analyte	Units							
Alkalinity	mg/L		ND	ND	29.8	31.4	5.00	J ND
Nitrate	mg/L		1.19	1.02 J	2.16	1.36	2.81	3.08
Sulfate	mg/L		8.41	9.02	21.8	17.4	14.2	13.1
Methane	ug/L		ND	ND	ND	ND	ND	ND
Total Organic Carbon	mg/L		ND	ND	ND	ND	1.24	0.863 J
pH ¹	NA		3.65	4.43	5.44	5.86	4.48	4.47
Dissolved Oxygen (DO) ¹	mg/L		8.87	8.24	3.01	2.45	0.22	0.36
Oxygen Reduction Potential (ORP) ¹	Mv		390	359	189	183	281	313
Ferrous Iron ²	mg/L		0.11	0.04	0.6	0.01	0.6	0.3

¹ pH, DO and ORP readings measured in the field during sampling
with a Horiba U-22 Water Quality Meter.

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TABLE B-4
Natural Attenuation Analytical Results - Groundwater Monitoring Wells at Site 3

New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, New Jersey

		Sample ID		3MW402-01		3MW402-02		3MW402D-01		3MW402D-02		3MW403-01		3MW403-02	
		Laboratory ID		NPG3386-02		NPK0071-01		NPG3386-01		NPK0071-02		NPG3386-06		NPK0267-04	
		Date		7/26/2006		10/31/2006		7/26/2006		10/31/2006		4/26/2006		11/1/2006	
		Matrix		Water		Water		Water		Water		Water		Water	
Analyte	Units														
Alkalinity	mg/L	7.8	J	8.00	J	5.6	J	ND		ND		ND			
Nitrate	mg/L	2.63		2.46	J	1.88		1.25	J	8.28		8.82			
Sulfate	mg/L	24.6	B	27.2	J	ND	B	1.76		26.9		23			
Methane	ug/L	ND		ND		ND		ND		ND		ND			
Total Organic Carbon	mg/L	ND		ND		ND		ND		0.463	J	ND			
pH ¹	NA	4.85		5.05		4.9		4.67		4.2		4.41			
Dissolved Oxygen (DO) ¹	mg/L	5.17		5.31		2.75		5.03		7.42		7			
Oxygen Reduction Potential (ORP) ¹	Mv	335		290		288		321		390		340			
Ferrous Iron ²	mg/L	0.01		0.01		0.7		0.02		0.01		0.02			

¹ pH, DO and ORP readings measured in the field during sampling
with a Horiba U-22 Water Quality Meter.

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² Ferrous iron measured in the field using a Hach Dissolved Iron test kit.

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analyte being detected in blank sample

J = Estimated Value

TABLE B-4
Natural Attenuation Analytical Results - Groundwater Monitoring Wells at Site 3

New Jersey Air National Guard
177th Fighter Wing
Egg Harbor Township, New Jersey

		Sample ID	3MW404D-01	3MW404D-02	3MW405-01	3MW405-02	3MW406-01	3MW406-02	3MW406D-01	3MW406D-02
		Laboratory ID	NPG3590-07	NPK0431-02	NPG3386-04	NPK0071-06	NPG3590-02	NPK0071-07	NPG3590-01	NPK0267-05
		Date	7/27/2006	11/2/2006	4/26/2006	10/31/2006	7/27/2006	10/31/2006	7/27/2006	11/1/2006
		Matrix	Water	Water	Water	Water	Water	Water	Water	Water
Analyte		Units								
Alkalinity	mg/L		ND		ND		ND		ND	
Nitrate	mg/L		0.948		0.956		3.78		3.97	J
Sulfate	mg/L		ND		0.71	J	28.4		28.4	
Methane	ug/L		ND		ND		ND		ND	
Total Organic Carbon	mg/L		ND		ND		0.64	J	ND	
pH ¹	NA		4.12		4.66		4.16		4.42	
Dissolved Oxygen (DO) ¹	mg/L		7.57		8.71		3.72		4.01	
Oxygen Reduction Potential (ORP) ¹	Mv		350		331		343		346	
Ferrous Iron ²	mg/L		0.02		0.0		0.01		0.15	

¹ pH, DO and ORP readings measured in the field during sampling

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ND = Not Detected above laboratory method detection limits (MDLs)

NA = No standard established for this analyte

B = Detected, however was qualified as non-detect due to analyte being detected in blank sample

J = Estimated Value

TABLE B-5

Soil Analytical Results – Site 6
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJ SOIL REMEDIATION STANDARDS* (mg/kg)				Sample ID Depth Interval (ft) Laboratory ID Date Matrix	6SS-01-6"	6SS-01-2'	6SS-02-6"	6SS-02-2'	6SS-03-6"
Residential Direct Contact	Non- Res. Direct Contact	Impact to GW Soil Screening Level	PQL		0.0 - 0.5	1.5 - 2.0	0.0 - 0.5	1.5 - 2.0	0.0 - 0.5
					NPC1136-01	NPC1136-02	NPC1136-03	NPC1136-04	NPC1136-05
					3/7/2006	3/7/2006	3/7/2006	3/7/2006	3/7/2006
					Soil	Soil	Soil	Soil	Soil
INORGANIC COMPOUNDS (mg/kg):									
400	800	59	1	Lead	9.56	3.41	7.67	3.21	14.5
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg):									
3,400	37,000	74	0.2	Acenaphthene	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Acenaphthylene	ND	ND	ND	ND	ND
17,000	30,000	1,500	0.2	Anthracene	ND	ND	ND	ND	ND
0.6	2	0.5	0.2	Benzo(a)anthracene	ND	ND	ND	ND	ND
0.20	0.20	0.20	0.2	Benzo(a)pyrene	ND	ND	ND	ND	ND
0.6	2	2	0.2	Benzo(b)fluoranthene	ND	ND	0.0393 J	ND	ND
380,000	30,000	NA	0.2	Benzo(g,h,i)perylene	ND	ND	ND	ND	ND
6	23	16	0.2	Benzo(k)fluoranthene	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
1,200	14,000	150	0.2	Butyl benzyl phthalate	ND	ND	ND	ND	ND
24	96	NA	0.2	Carbazole	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	Bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND
0.4	2	0.2	0.2	Bis (2-chloroethyl) ether	ND	ND	ND	ND	ND
23	67	3	0.2	Bis (2-chloroisopropyl) ether	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Chloronaphthalene	ND	ND	ND	ND	ND
310	2,200	0.5	0.2	2-Chlorophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
62	230	52	0.2	Chrysene	ND	ND	ND	ND	ND
0.2	0.2	0.5	0.2	Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dibenzofuran	ND	ND	ND	ND	ND
6,100	68,000	620	0.2	Di-N-Butylphthalate	ND	ND	ND	ND	ND
5	13	1	0.005	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	11	0.005	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	12	0.005	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1	4	0.2	0.2	3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
180	2,100	0.2	0.2	2,4-Dichlorophenol	ND	ND	ND	ND	ND
49,000	550,000	57	0.2	Diethylphthalate	ND	ND	ND	ND	ND
1,200	14,000	1	0.2	2,4-Dimethylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dimethyl phthalate	ND	ND	ND	ND	ND
6	68	NA	0.3	4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
120	1,400	0.3	0.3	2,4-Dinitrophenol	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,6-Dinitrotoluene	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,400	27,000	3,300	0.2	Di-n-octyl phthalate	ND	ND	ND	ND	ND
35	140	790	0.2	Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND
2,300	24,000	840	0.2	Fluoranthene	ND	ND	0.0779 J	ND	0.0449 J
2,300	24,000	110	0.2	Fluorene	ND	ND	ND	ND	ND
0.3	1	0.2	0.2	Hexachlorobenzene	ND	ND	ND	ND	ND
6	25	1	0.2	Hexachlorobutadiene	ND	ND	ND	ND	ND
45	110	210	0.2	Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
35	140	0.2	0.2	Hexachloroethane	ND	ND	ND	ND	ND
0.6	2	5	0.2	Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
510	2,000	0.2	0.2	Isophorone	ND	ND	ND	ND	ND
230	2,400	5	0.17	2-Methylnaphthalene	ND	ND	ND	ND	ND
310	3,400	NA	0.2	2-Methylphenol	ND	ND	ND	ND	ND
6	17	16	0.2	Napthalene	ND	ND	ND	ND	ND
39	23,000	NA	0.3	2-Nitroaniline	ND	ND	<0.127	<0.135	ND
NA	NA	NA	NA	3-Nitroaniline	ND	ND	<0.0983	<0.104	ND
NA	NA	NA	NA	4-Nitroaniline	ND	ND	<0.0705	<0.0748	ND
31	340	NA	0.2	3/4-Methylphenol	ND	ND	ND	ND	ND
31	340	0.2	0.2	Nitrobenzene	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Nitrophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitrophenol	ND	ND	ND	ND	ND
99	390	0.2	0.2	N-Nitrosodiphenylamine	ND	ND	ND	ND	ND
0.2	0.3	0.2	0.2	N-Nitroso-Di-N-Propylamine	ND	ND	ND	ND	ND
3	10	0.3	0.3	Pentachlorophenol	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Phenanthrene	ND	ND	ND	ND	ND
18,000	210,000	5	0.2	Phenol	ND	ND	ND	ND	ND
1,700	18,000	550	0.2	Pyrene	ND	ND	0.0624 J	ND	ND
NA	NA	NA	NA	Pyridine	ND	ND	ND	ND	ND
73	820	0.4	0.005	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
19	74	0.2	0.2	2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
6,100	68,000	44	0.2	2,4,5-Trichlorophenol	ND	ND	ND	ND	ND

notes:

* New Jersey Department of Environmental Protection Remediation Standards N.J.A.C. 7:26D, last Analytical results above the PQL or the NJDEP Impact to Groundwater Screening Levels are shown in bold. Results exceeding the Non-Residential Direct Contact Remediation Standards are shaded.

ND - Not detected.

NA - Not applicable or not established.

J Estimated value

NR - Not reported

Validation: With the exceptions of SB-13-5' and sample results < 16 mg/kg, lead soil sample results in raw values were less than 10 times the field blank concentration. In accordance with EPA Region 2 guidance, lead corresponding results have been qualified as estimated values (J).

TABLE B-5

Soil Analytical Results – Site 6
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJ SOIL REMEDIATION STANDARDS* (mg/kg)				Sample ID Depth Interval (ft) Laboratory ID Date Matrix	6SS-08-2'	6SS-09-6"	6SS-09-2'	6SS-10-6"	6SS-10-2'
Residential Direct Contact	Non- Res. Direct Contact	Impact to GW Soil Screening Level	PQL		1.5 - 2.0	0.0 - 0.5	1.5 - 2.0	0.0 - 0.5	1.5 - 2.0
					NPC1136-17	NPC1136-18	NPC1136-19	NPC1136-20	NPC1136-21
					3/7/2006	3/7/2006	3/7/2006	3/7/2006	3/7/2006
					Soil	Soil	Soil	Soil	Soil
INORGANIC COMPOUNDS (mg/kg):									
400	800	59	1	Lead	5.75	9.12	5.2	157	34.3
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg):									
3,400	37,000	74	0.2	Acenaphthene	ND	ND	ND	1.83 J	ND
NA	300,000	NA	0.2	Acenaphthylene	ND	ND	ND	ND	ND
17,000	30,000	1,500	0.2	Anthracene	ND	ND	ND	0.19 J	ND
0.6	2	0.5	0.2	Benzo(a)anthracene	ND	ND	ND	3.67 J	ND
0.20	0.20	0.20	0.2	Benzo(a)pyrene	ND	ND	ND	3.12 J	ND
0.6	2	2	0.2	Benzo(b)fluoranthene	ND	ND	ND	3	ND
380,000	30,000	NA	0.2	Benzo(g,h,i)perylene	ND	ND	ND	1.22 J	ND
6	23	16	0.2	Benzo(k)fluoranthene	ND	ND	ND	2.59	ND
NA	NA	NA	NA	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
1,200	14,000	150	0.2	Butyl benzyl phthalate	ND	ND	ND	ND	ND
24	96	NA	0.2	Carbazole	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	Bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND
0.4	2	0.2	0.2	Bis (2-chloroethyl) ether	ND	ND	ND	ND	ND
23	67	3	0.2	Bis (2-chloroisopropyl) ether	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Chloronaphthalene	ND	ND	ND	ND	ND
310	2,200	0.5	0.2	2-Chlorophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
62	230	52	0.2	Chrysene	ND	ND	ND	3.69	ND
0.2	0.2	0.5	0.2	Dibenzo(a,h)anthracene	ND	ND	ND	0.933 J	ND
NA	NA	NA	NA	Dibenzofuran	ND	ND	ND	1.09 J	ND
6,100	68,000	620	0.2	Di-N-Butylphthalate	ND	ND	ND	ND	ND
5	13	1	0.005	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	11	0.005	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	12	0.005	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1	4	0.2	0.2	3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
180	2,100	0.2	0.2	2,4-Dichlorophenol	ND	ND	ND	ND	ND
49,000	550,000	57	0.2	Diethylphthalate	ND	ND	ND	ND	ND
1,200	14,000	1	0.2	2,4-Dimethylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dimethyl phthalate	ND	ND	ND	ND	ND
6	68	NA	0.3	4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
120	1,400	0.3	0.3	2,4-Dinitrophenol	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,6-Dinitrotoluene	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,400	27,000	3,300	0.2	Di-n-octyl phthalate	ND	ND	ND	ND	ND
35	140	790	0.2	Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND
2,300	24,000	840	0.2	Fluoranthene	ND	ND	ND	8.09	ND
2,300	24,000	110	0.2	Fluorene	ND	ND	ND	1.02 J	ND
0.3	1	0.2	0.2	Hexachlorobenzene	ND	ND	ND	ND	ND
6	25	1	0.2	Hexachlorobutadiene	ND	ND	ND	ND	ND
45	110	210	0.2	Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
35	140	0.2	0.2	Hexachloroethane	ND	ND	ND	ND	ND
0.6	2	5	0.2	Indeno(1,2,3-cd)pyrene	ND	ND	ND	1.15 J	ND
510	2,000	0.2	0.2	Isophorone	ND	ND	ND	ND	ND
230	2,400	5	0.17	2-Methylnaphthalene	ND	ND	ND	ND	ND
310	3,400	NA	0.2	2-Methylphenol	ND	ND	ND	ND	ND
6	17	16	0.2	Napthalene	ND	ND	ND	ND	ND
39	23,000	NA	0.3	2-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	3-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitroaniline	ND	ND	ND	ND	ND
31	340	NA	0.2	3/4-Methylphenol	ND	ND	ND	ND	ND
31	340	0.2	0.2	Nitrobenzene	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Nitrophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitrophenol	ND	ND	ND	ND	ND
99	390	0.2	0.2	N-Nitrosodiphenylamine	ND	ND	ND	ND	ND
0.2	0.3	0.2	0.2	N-Nitroso-Di-N-Propylamine	ND	ND	ND	ND	ND
3	10	0.3	0.3	Pentachlorophenol	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Phenanthrene	ND	ND	ND	1.29 J	ND
18,000	210,000	5	0.2	Phenol	ND	ND	ND	ND	ND
1,700	18,000	550	0.2	Pyrene	ND	ND	ND	6.83	ND
NA	NA	NA	NA	Pyridine	ND	ND	ND	ND	ND
73	820	0.4	0.005	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
19	74	0.2	0.2	2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
6,100	68,000	44	0.2	2,4,5-Trichlorophenol	ND	ND	ND	ND	ND

notes:
* New Jersey Department of Environmental Protection Remediation Standards N.J.A.C. 7:26D, last
Analytical results above the PQL or the NJDEP Impact to Groundwater Screening Levels are shown in
bold; Results exceeding the Non-Residential Direct Contact Remediation Standards are shaded.
ND - Not detected.
NA - Not applicable or not established.
J Estimated value
NR - Not reported
Validation: With the exceptions of SB-13-5' and sample results < 16 mg/kg, lead soil sample results in
raw values were less than 10 times the field blank concentration. In accordance with EPA Region 2
guidance, lead corresponding results have been qualified as estimated values (J).

TABLE B-5

Soil Analytical Results – Site 6
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJ SOIL REMEDIATION STANDARDS* (mg/kg)				Sample ID Depth Interval (ft) Laboratory ID Date Matrix	6SS-11-6"	6SS-11-2'	6SS-12-6"	6SS-12-2'	6SS-13-6"
Residential Direct Contact	Non- Res. Direct Contact	Impact to GW Soil Screening Level	PQL		0.0 - 0.5	1.5 - 2.0	0.0 - 0.5	1.5 - 2.0	0.0 - 0.5
					NPC1136-22	NPC1136-23	NPC1136-24	NPC1136-25	NPC1136-26
					3/7/2006	3/7/2006	3/7/2006	3/7/2006	3/7/2006
					Soil	Soil	Soil	Soil	Soil
INORGANIC COMPOUNDS (mg/kg):									
400	800	59	1	Lead	31.3	6.33	34.2	7.56	278
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg):									
3,400	37,000	74	0.2	Acenaphthene	1.52	ND	0.193 J	ND	1.31
NA	300,000	NA	0.2	Acenaphthylene	ND	ND	ND	ND	0.044 J
17,000	30,000	1,500	0.2	Anthracene	ND	ND	ND	ND	0.123 J
0.6	2	0.5	0.2	Benzo(a)anthracene	1.13	ND	0.388	ND	2.11
0.20	0.20	0.20	0.2	Benzo(a)pyrene	1.03	ND	0.372	ND	1.87
0.6	2	2	0.2	Benzo(b)fluoranthene	0.963	ND	0.408	ND	2.05
380,000	30,000	NA	0.2	Benzo(g,h,i)perylene	0.582	ND	0.22 J	ND	1.03
6	23	16	0.2	Benzo(k)fluoranthene	0.996	ND	0.267 J	ND	1.29
NA	NA	NA	NA	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
1,200	14,000	150	0.2	Butyl benzyl phthalate	ND	0.088 J	ND	ND	ND
24	96	NA	0.2	Carbazole	0.113 J	ND	ND	ND	0.142 J
NA	NA	NA	NA	4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	Bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND
0.4	2	0.2	0.2	Bis (2-chloroethyl) ether	ND	ND	ND	ND	ND
23	67	3	0.2	Bis (2-chloroisopropyl) ether	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Chloronaphthalene	ND	ND	ND	ND	ND
310	2,200	0.5	0.2	2-Chlorophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
62	230	52	0.2	Chrysene	1.34	ND	0.413	ND	2.11
0.2	0.2	0.5	0.2	Dibenzo(a,h)anthracene	0.261 J	ND	0.101 J	ND	0.497
NA	NA	NA	NA	Dibenzofuran	1.4	ND	0.131 J	ND	0.711
6,100	68,000	620	0.2	Di-N-Butylphthalate	ND	ND	ND	ND	ND
5	13	1	0.005	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	11	0.005	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	12	0.005	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1	4	0.2	0.2	3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
180	2,100	0.2	0.2	2,4-Dichlorophenol	ND	ND	ND	ND	ND
49,000	550,000	57	0.2	Diethylphthalate	ND	ND	ND	ND	ND
1,200	14,000	1	0.2	2,4-Dimethylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dimethyl phthalate	ND	ND	ND	ND	ND
6	68	NA	0.3	4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
120	1,400	0.3	0.3	2,4-Dinitrophenol	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,6-Dinitrotoluene	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,400	27,000	3,300	0.2	Di-n-octyl phthalate	ND	ND	ND	ND	ND
35	140	790	0.2	Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	0.206 J
2,300	24,000	840	0.2	Fluoranthene	2.98	ND	0.784	ND	2.87
2,300	24,000	110	0.2	Fluorene	0.624	ND	0.0984 J	ND	0.612
0.3	1	0.2	0.2	Hexachlorobenzene	ND	ND	ND	ND	ND
6	25	1	0.2	Hexachlorobutadiene	ND	ND	ND	ND	ND
45	110	210	0.2	Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
35	140	0.2	0.2	Hexachloroethane	ND	ND	ND	ND	ND
0.6	2	5	0.2	Indeno(1,2,3-cd)pyrene	0.585	ND	0.217 J	ND	1.05
510	2,000	0.2	0.2	Isophorone	ND	ND	ND	ND	ND
230	2,400	5	0.17	2-Methylnaphthalene	0.297 J	ND	ND	ND	0.0844 J
310	3,400	NA	0.2	2-Methylphenol	ND	ND	ND	ND	ND
6	17	16	0.2	Napthalene	ND	ND	ND	ND	ND
39	23,000	NA	0.3	2-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	3-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitroaniline	ND	ND	ND	ND	ND
31	340	NA	0.2	3/4-Methylphenol	ND	ND	ND	ND	ND
31	340	0.2	0.2	Nitrobenzene	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Nitrophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitrophenol	ND	ND	ND	ND	ND
99	390	0.2	0.2	N-Nitrosodiphenylamine	ND	ND	ND	ND	ND
0.2	0.3	0.2	0.2	N-Nitroso-Di-N-Propylamine	ND	ND	ND	ND	ND
3	10	0.3	0.3	Pentachlorophenol	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Phenanthrene	0.855	ND	ND	ND	0.885
18,000	210,000	5	0.2	Phenol	ND	ND	ND	ND	ND
1,700	18,000	550	0.2	Pyrene	2.53	ND	0.677	ND	3.57
NA	NA	NA	NA	Pyridine	ND	ND	ND	ND	ND
73	820	0.4	0.005	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
19	74	0.2	0.2	2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
6,100	68,000	44	0.2	2,4,5-Trichlorophenol	ND	ND	ND	ND	ND

notes:

* New Jersey Department of Environmental Protection Remediation Standards N.J.A.C. 7:26D, last Analytical results above the PQL or the NJDEP Impact to Groundwater Screening Levels are shown in bold; Results exceeding the Non-Residential Direct Contact Remediation Standards are shaded.

ND - Not detected.

NA - Not applicable or not established.

J Estimated value

NR - Not reported

Validation: With the exceptions of SB-13-5' and sample results < 16 mg/kg, lead soil sample results in raw values were less than 10 times the field blank concentration. In accordance with EPA Region 2 guidance, lead corresponding results have been qualified as estimated values (J).

TABLE B-5
Soil Analytical Results – Site 6
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJ SOIL REMEDIATION STANDARDS* (mg/kg)				Sample ID Depth Interval (ft) Laboratory ID Date Matrix	6SS-13-2'	6SS-14-6"	6SS-14-2'	6SS-15-6"	6SS-15-2'
Residential Direct Contact	Non- Res. Direct Contact	Impact to GW Soil Screening Level	PQL		1.5 - 2.0	0.0 - 0.5	1.5 - 2.0	0.0 - 0.5	1.5 - 2.0
					NPC1136-27	NPC1136-28	NPC1136-29	NPC1136-30	NPC1136-31
					3/7/2006	3/7/2006	3/7/2006	3/7/2006	3/7/2006
					Soil	Soil	Soil	Soil	Soil
INORGANIC COMPOUNDS (mg/kg):									
400	800	59	1	Lead	9.8	50.4	8.98	11.1	5.16
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg):									
3,400	37,000	74	0.2	Acenaphthene	ND	0.682	ND	ND	ND
NA	300,000	NA	0.2	Acenaphthylene	ND	ND	ND	ND	ND
17,000	30,000	1,500	0.2	Anthracene	ND	ND	ND	ND	ND
0.6	2	0.5	0.2	Benzo(a)anthracene	ND	0.634	ND	ND	ND
0.20	0.20	0.20	0.2	Benzo(a)pyrene	ND	0.533	ND	ND	ND
0.6	2	2	0.2	Benzo(b)fluoranthene	ND	0.629	ND	ND	ND
380,000	30,000	NA	0.2	Benzo(g,h,i)perylene	ND	0.314 J	ND	ND	ND
6	23	16	0.2	Benzo(k)fluoranthene	ND	0.397	ND	ND	ND
NA	NA	NA	NA	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
1,200	14,000	150	0.2	Butyl benzyl phthalate	ND	ND	ND	ND	ND
24	96	NA	0.2	Carbazole	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	Bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND
0.4	2	0.2	0.2	Bis (2-chloroethyl) ether	ND	ND	ND	ND	ND
23	67	3	0.2	Bis (2-chloroisopropyl) ether	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Chloronaphthalene	ND	ND	ND	ND	ND
310	2,200	0.5	0.2	2-Chlorophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
62	230	52	0.2	Chrysene	ND	0.662	ND	ND	ND
0.2	0.2	0.5	0.2	Dibenzo(a,h)anthracene	ND	0.139 J	ND	ND	ND
NA	NA	NA	NA	Dibenzofuran	ND	0.608	ND	ND	ND
6,100	68,000	620	0.2	Di-N-Butylphthalate	ND	ND	ND	ND	ND
5	13	1	0.005	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	11	0.005	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	12	0.005	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1	4	0.2	0.2	3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
180	2,100	0.2	0.2	2,4-Dichlorophenol	ND	ND	ND	ND	ND
49,000	550,000	57	0.2	Diethylphthalate	ND	ND	ND	ND	ND
1,200	14,000	1	0.2	2,4-Dimethylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dimethyl phthalate	ND	ND	ND	ND	ND
6	68	NA	0.3	4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
120	1,400	0.3	0.3	2,4-Dinitrophenol	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,6-Dinitrotoluene	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,400	27,000	3,300	0.2	Di-n-octyl phthalate	ND	ND	ND	ND	ND
35	140	790	0.2	Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND
2,300	24,000	840	0.2	Fluoranthene	ND	1.33	ND	0.0413 J	ND
2,300	24,000	110	0.2	Fluorene	ND	0.324 J	ND	ND	ND
0.3	1	0.2	0.2	Hexachlorobenzene	ND	ND	ND	ND	ND
6	25	1	0.2	Hexachlorobutadiene	ND	ND	ND	ND	ND
45	110	210	0.2	Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
35	140	0.2	0.2	Hexachloroethane	ND	ND	ND	ND	ND
0.6	2	5	0.2	Indeno(1,2,3-cd)pyrene	ND	0.311 J	ND	ND	ND
510	2,000	0.2	0.2	Isophorone	ND	ND	ND	ND	ND
230	2,400	5	0.17	2-Methylnaphthalene	ND	0.105 J	ND	ND	ND
310	3,400	NA	0.2	2-Methylphenol	ND	ND	ND	ND	ND
6	17	16	0.2	Napthalene	ND	ND	ND	ND	ND
39	23,000	NA	0.3	2-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	3-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitroaniline	ND	ND	ND	ND	ND
31	340	NA	0.2	3/4-Methylphenol	ND	ND	ND	ND	ND
31	340	0.2	0.2	Nitrobenzene	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Nitrophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitrophenol	ND	ND	ND	ND	ND
99	390	0.2	0.2	N-Nitrosodiphenylamine	ND	ND	ND	ND	ND
0.2	0.3	0.2	0.2	N-Nitroso-Di-N-Propylamine	ND	ND	ND	ND	ND
3	10	0.3	0.3	Pentachlorophenol	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Phenanthrene	ND	ND	ND	ND	ND
18,000	210,000	5	0.2	Phenol	ND	ND	ND	ND	ND
1,700	18,000	550	0.2	Pyrene	ND	1.17	ND	ND	ND
NA	NA	NA	NA	Pyridine	ND	ND	ND	ND	ND
73	820	0.4	0.005	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
19	74	0.2	0.2	2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
6,100	68,000	44	0.2	2,4,5-Trichlorophenol	ND	ND	ND	ND	ND

notes:
* New Jersey Department of Environmental Protection Remediation Standards N.J.A.C. 7:26D, last
Analytical results above the PQL or the NJDEP Impact to Groundwater Screening Levels are shown in
bold; Results exceeding the Non-Residential Direct Contact Remediation Standards are shaded.
ND - Not detected.
NA - Not applicable or not established.
J Estimated value
NR - Not reported
Validation: With the exceptions of SB-13-5' and sample results < 16 mg/kg, lead soil sample results in
raw values were less than 10 times the field blank concentration. In accordance with EPA Region 2
guidance, lead corresponding results have been qualified as estimated values (J).

TABLE B-5

Soil Analytical Results – Site 6
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJ SOIL REMEDIATION STANDARDS* (mg/kg)				Sample ID Depth Interval (ft) Laboratory ID Date Matrix	6SS-16-6"	6SS-16-2'	6SS-17-6"	6SS-17-2'	6SS-18-6"
Residential Direct Contact	Non- Res. Direct Contact	Impact to GW Soil Screening Level	PQL		0.0 - 0.5	1.5 - 2.0	0.0 - 0.5	1.5 - 2.0	0.0 - 0.5
					NPC1136-32	NPC1136-33	NPC1136-35	NPC1136-36	NPC1136-37
					3/7/2006	3/7/2006	3/7/2006	3/7/2006	3/7/2006
					Soil	Soil	Soil	Soil	Soil
INORGANIC COMPOUNDS (mg/kg):									
400	800	59	1	Lead	11.1	7.99	79.1	2.75	45.8
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg):									
3,400	37,000	74	0.2	Acenaphthene	0.0734 J	0.0426 J	0.614	ND	0.547
NA	300,000	NA	0.2	Acenaphthylene	ND	ND	0.0358 J	ND	ND
17,000	30,000	1,500	0.2	Anthracene	ND	ND	0.0699 J	ND	0.0394 J
0.6	2	0.5	0.2	Benzo(a)anthracene	1.45 J	0.0781 J	1.67	ND	0.613
0.20	0.20	0.20	0.2	Benzo(a)pyrene	0.127 J	0.0757 J	1.52	ND	0.523
0.6	2	2	0.2	Benzo(b)fluoranthene	0.124 J	0.0767 J	1.59	ND	0.524
380,000	30,000	NA	0.2	Benzo(g,h,i)perylene	0.079 J	0.0487 J	0.869	ND	0.3 J
6	23	16	0.2	Benzo(k)fluoranthene	0.11 J	0.0659 J	1.23	ND	0.425
NA	NA	NA	NA	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
1,200	14,000	150	0.2	Butyl benzyl phthalate	ND	ND	ND	ND	ND
24	96	NA	0.2	Carbazole	ND	ND	0.0817 J	ND	ND
NA	NA	NA	NA	4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	Bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND
0.4	2	0.2	0.2	Bis (2-chloroethyl) ether	ND	ND	ND	ND	ND
23	67	3	0.2	Bis (2-chloroisopropyl) ether	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Chloronaphthalene	ND	ND	ND	ND	ND
310	2,200	0.5	0.2	2-Chlorophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
62	230	52	0.2	Chrysene	0.14 J	0.0818 J	1.72	ND	0.599
0.2	0.2	0.5	0.2	Dibenzo(a,h)anthracene	ND	ND	0.414	ND	0.111 J
NA	NA	NA	NA	Dibenzofuran	ND	ND	0.316 J	ND	0.333 J
6,100	68,000	620	0.2	Di-N-Butylphthalate	ND	ND	ND	ND	ND
5	13	1	0.005	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	11	0.005	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	12	0.005	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1	4	0.2	0.2	3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
180	2,100	0.2	0.2	2,4-Dichlorophenol	ND	ND	ND	ND	ND
49,000	550,000	57	0.2	Diethylphthalate	ND	ND	ND	ND	ND
1,200	14,000	1	0.2	2,4-Dimethylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dimethyl phthalate	ND	ND	ND	ND	ND
6	68	NA	0.3	4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
120	1,400	0.3	0.3	2,4-Dinitrophenol	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,6-Dinitrotoluene	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,400	27,000	3,300	0.2	Di-n-octyl phthalate	ND	ND	ND	ND	ND
35	140	790	0.2	Bis(2-ethylhexyl)phthalate	ND	ND	0.0702 J	ND	0.158 J
2,300	24,000	840	0.2	Fluoranthene	0.253 J	0.139 J	3.25	ND	1.29
2,300	24,000	110	0.2	Fluorene	ND	ND	0.286 J	ND	0.252 J
0.3	1	0.2	0.2	Hexachlorobenzene	ND	ND	ND	ND	ND
6	25	1	0.2	Hexachlorobutadiene	ND	ND	ND	ND	ND
45	110	210	0.2	Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
35	140	0.2	0.2	Hexachloroethane	ND	ND	ND	ND	ND
0.6	2	5	0.2	Indeno(1,2,3-cd)pyrene	0.0797 J	0.0514 J	0.879 J	ND	0.295 J
510	2,000	0.2	0.2	Isophorone	ND	ND	ND	ND	ND
230	2,400	5	0.17	2-Methylnaphthalene	ND	ND	0.0456 J	ND	0.0555 J
310	3,400	NA	0.2	2-Methylphenol	ND	ND	ND	ND	ND
6	17	16	0.2	Napthalene	ND	ND	ND	ND	ND
39	23,000	NA	0.3	2-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	3-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitroaniline	ND	ND	ND	ND	ND
31	340	NA	0.2	3/4-Methylphenol	ND	ND	ND	ND	ND
31	340	0.2	0.2	Nitrobenzene	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Nitrophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitrophenol	ND	ND	ND	ND	ND
99	390	0.2	0.2	N-Nitrosodiphenylamine	ND	ND	ND	ND	ND
0.2	0.3	0.2	0.2	N-Nitroso-Di-N-Propylamine	ND	ND	ND	ND	ND
3	10	0.3	0.3	Pentachlorophenol	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Phenanthrene	ND	ND	0.461	ND	0.335 J
18,000	210,000	5	0.2	Phenol	ND	ND	ND	ND	ND
1,700	18,000	550	0.2	Pyrene	0.228 J	0.125 J	2.73	ND	1.07
NA	NA	NA	NA	Pyridine	ND	ND	ND	ND	ND
73	820	0.4	0.005	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
19	74	0.2	0.2	2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
6,100	68,000	44	0.2	2,4,5-Trichlorophenol	ND	ND	ND	ND	ND

notes:

* New Jersey Department of Environmental Protection Remediation Standards N.J.A.C. 7:26D, last
Analytical results above the PQL or the NJDEP Impact to Groundwater Screening Levels are shown in
bold; Results exceeding the Non-Residential Direct Contact Remediation Standards are shaded.

ND - Not detected.

NA - Not applicable or not established.

J Estimated value

NR - Not reported

Validation: With the exceptions of SB-13-5' and sample results < 16 mg/kg, lead soil sample results in
raw values were less than 10 times the field blank concentration. In accordance with EPA Region 2
guidance, lead corresponding results have been qualified as estimated values (J).

TABLE B-5
Soil Analytical Results – Site 6
New Jersey Air National Guard, 177th Fighter Wing, Egg Harbor Township, New Jersey

NJ SOIL REMEDIATION STANDARDS* (mg/kg)				Sample ID Depth Interval (ft) Laboratory ID Date Matrix	6SS-18-2'	6SS-19-6"	6SS-19-2'	6SS-20-6"	6SS-20-2'
Residential Direct Contact	Non- Res. Direct Contact	Impact to GW Soil Screening Level	PQL		1.5 - 2.0	0.0 - 0.5	1.5 - 2.0	0.0 - 0.5	1.5 - 2.0
					NPC1136-38	NPC1136-39	NPC1136-40	NPC1136-41	NPC1136-42
					3/7/2006	3/7/2006	3/7/2006	3/7/2006	3/7/2006
					Soil	Soil	Soil	Soil	Soil
INORGANIC COMPOUNDS (mg/kg):									
400	800	59	1	Lead	7.2	12.9	2.98	14.4	7.47
SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg):									
3,400	37,000	74	0.2	Acenaphthene	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Acenaphthylene	ND	ND	ND	ND	ND
17,000	30,000	1,500	0.2	Anthracene	ND	ND	ND	ND	ND
0.6	2	0.5	0.2	Benzo(a)anthracene	ND	ND	ND	ND	ND
0.20	0.20	0.20	0.2	Benzo(a)pyrene	ND	ND	ND	ND	ND
0.6	2	2	0.2	Benzo(b)fluoranthene	ND	ND	ND	ND	ND
380,000	30,000	NA	0.2	Benzo(g,h,i)perylene	ND	ND	ND	ND	ND
6	23	16	0.2	Benzo(k)fluoranthene	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
1,200	14,000	150	0.2	Butyl benzyl phthalate	ND	ND	ND	ND	ND
24	96	NA	0.2	Carbazole	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chloroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	Bis(2-chloroethoxy)methane	ND	ND	ND	ND	ND
0.4	2	0.2	0.2	Bis (2-chloroethyl) ether	ND	ND	ND	ND	ND
23	67	3	0.2	Bis (2-chloroisopropyl) ether	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Chloronaphthalene	ND	ND	ND	ND	ND
310	2,200	0.5	0.2	2-Chlorophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
62	230	52	0.2	Chrysene	ND	ND	ND	ND	ND
0.2	0.2	0.5	0.2	Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dibenzofuran	ND	ND	ND	ND	ND
6,100	68,000	620	0.2	Di-N-Butylphthalate	ND	ND	ND	ND	ND
5	13	1	0.005	1,4-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	11	0.005	1,2-Dichlorobenzene	ND	ND	ND	ND	ND
5,300	59,000	12	0.005	1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1	4	0.2	0.2	3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
180	2,100	0.2	0.2	2,4-Dichlorophenol	ND	ND	ND	ND	ND
49,000	550,000	57	0.2	Diethylphthalate	ND	ND	ND	ND	ND
1,200	14,000	1	0.2	2,4-Dimethylphenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	Dimethyl phthalate	ND	ND	ND	ND	ND
6	68	NA	0.3	4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
120	1,400	0.3	0.3	2,4-Dinitrophenol	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,6-Dinitrotoluene	ND	ND	ND	ND	ND
0.7	3	NA	0.2	2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,400	27,000	3,300	0.2	Di-n-octyl phthalate	ND	ND	ND	ND	ND
35	140	790	0.2	Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND
2,300	24,000	840	0.2	Fluoranthene	ND	0.0626 J	ND	ND	ND
2,300	24,000	110	0.2	Fluorene	ND	ND	ND	ND	ND
0.3	1	0.2	0.2	Hexachlorobenzene	ND	ND	ND	ND	ND
6	25	1	0.2	Hexachlorobutadiene	ND	ND	ND	ND	ND
45	110	210	0.2	Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
35	140	0.2	0.2	Hexachloroethane	ND	ND	ND	ND	ND
0.6	2	5	0.2	Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
510	2,000	0.2	0.2	Isophorone	ND	ND	ND	ND	ND
230	2,400	5	0.17	2-Methylnaphthalene	ND	ND	ND	ND	ND
310	3,400	NA	0.2	2-Methylphenol	ND	ND	ND	ND	ND
6	17	16	0.2	Napthalene	ND	ND	ND	ND	ND
39	23,000	NA	0.3	2-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	3-Nitroaniline	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitroaniline	ND	ND	ND	ND	ND
31	340	NA	0.2	3/4-Methylphenol	ND	ND	ND	ND	ND
31	340	0.2	0.2	Nitrobenzene	ND	ND	ND	ND	ND
NA	NA	NA	NA	2-Nitrophenol	ND	ND	ND	ND	ND
NA	NA	NA	NA	4-Nitrophenol	ND	ND	ND	ND	ND
99	390	0.2	0.2	N-Nitrosodiphenylamine	ND	ND	ND	ND	ND
0.2	0.3	0.2	0.2	N-Nitroso-Di-N-Propylamine	ND	ND	ND	ND	ND
3	10	0.3	0.3	Pentachlorophenol	ND	ND	ND	ND	ND
NA	300,000	NA	0.2	Phenanthrene	ND	ND	ND	ND	ND
18,000	210,000	5	0.2	Phenol	ND	ND	ND	ND	ND
1,700	18,000	550	0.2	Pyrene	ND	0.0472 J	ND	ND	ND
NA	NA	NA	NA	Pyridine	ND	ND	ND	ND	ND
73	820	0.4	0.005	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
19	74	0.2	0.2	2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
6,100	68,000	44	0.2	2,4,5-Trichlorophenol	ND	ND	ND	ND	ND

notes:

* New Jersey Department of Environmental Protection Remediation Standards N.J.A.C. 7:26D, last
Analytical results above the PQL or the NJDEP Impact to Groundwater Screening Levels are shown in
bold; Results exceeding the Non-Residential Direct Contact Remediation Standards are shaded.

ND - Not detected.

NA - Not applicable or not established.

J Estimated value

NR - Not reported

Validation: With the exceptions of SB-13-5' and sample results < 16 mg/kg, lead soil sample results in
raw values were less than 10 times the field blank concentration. In accordance with EPA Region 2
guidance, lead corresponding results have been qualified as estimated values (J).

APPENDIX C
BIOCHLOR Modeling Worksheets

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Scenario 1: BIOCHLOR Monitored Natural Attenuation of PCE Plume
Hotspot 1

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BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

NJANG Egg Harbor

IRP Site 3

Run Name

TYPE OF CHLORINATED SOLVENT:

Ethenes ☒

Ethanes ☐

1. ADVECTION

Seepage Velocity* Vs 117.5 (ft/yr)

or

Hydraulic Conductivity K 4.0E-03 (cm/sec)

Hydraulic Gradient i 0.0086 (ft/ft)

Effective Porosity n 0.3 (-)

2. DISPERSION

Alpha x* 20.564 (ft)

(Alpha y) / (Alpha x)* 2.0564 (-)

(Alpha z) / (Alpha x)* 1.E+00 (-)

3. ADSORPTION

Retardation Factor* R

or

Soil Bulk Density, rho 1.7 (kg/L)

Fraction Organic Carbon, f_{oc} 1.0E-3 (-)

Partition Coefficient K_{oc} 426 (L/kg)

PCE 3.41 (-)

TCE (-)

DCE (-)

VC (-)

ETH (-)

Common R (used in model)* = 3.41

4. BIOTRANSFORMATION

Zone 1 -1st Order Decay Coefficient*

PCE → TCE λ (1/yr) 0.000 half-life (yrs) 0.79 Yield 0.79

TCE → DCE λ (1/yr) 0.000 half-life (yrs) 0.74 Yield 0.74

DCE → VC λ (1/yr) 0.000 half-life (yrs) 0.64 Yield 0.64

VC → ETH λ (1/yr) 0.000 half-life (yrs) 0.45 Yield 0.45

Zone 2 -1st Order Decay Coefficient*

PCE → TCE λ (1/yr) 0.000 half-life (yrs) 0.79 Yield 0.79

TCE → DCE λ (1/yr) 0.000 half-life (yrs) 0.74 Yield 0.74

DCE → VC λ (1/yr) 0.000 half-life (yrs) 0.64 Yield 0.64

VC → ETH λ (1/yr) 0.000 half-life (yrs) 0.45 Yield 0.45

HELP

5. GENERAL

Simulation Time*

Modeled Area Width*

Modeled Area Length*

Zone 1 Length*

Zone 2 Length*

100 (yr)

200 (ft)

500 (ft)

500 (ft)

0 (ft)

Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options

TYPE: Decaying Spatially-Varying

Source Thickness in Sat. Zone* 45 (ft)

Y1 Y2 Y3

Width* (ft) 20 60 100

Conc. (mg/L)* C1 C2 C3 k_s* (1/yr)

PCE .048 0.030 0.020 0.1

TCE 0.1

DCE 0.1

VC 0.1

ETH 0.1

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)

TCE Conc. (mg/L)

DCE Conc. (mg/L)

VC Conc. (mg/L)

ETH Conc. (mg/L)

Distance from Source (ft)

Date Data Collected

2006

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

Restore Formulas

RESET

SEE OUTPUT

Paste Example

Data Input Instructions:

115

or

0.02

1. Enter value directly....or

2. Calculate by filling in gray

cells. Press Enter, then **C**

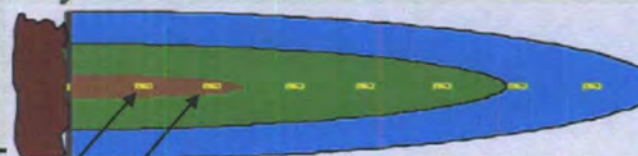
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring

Natural Attenuation Screening Protocol

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

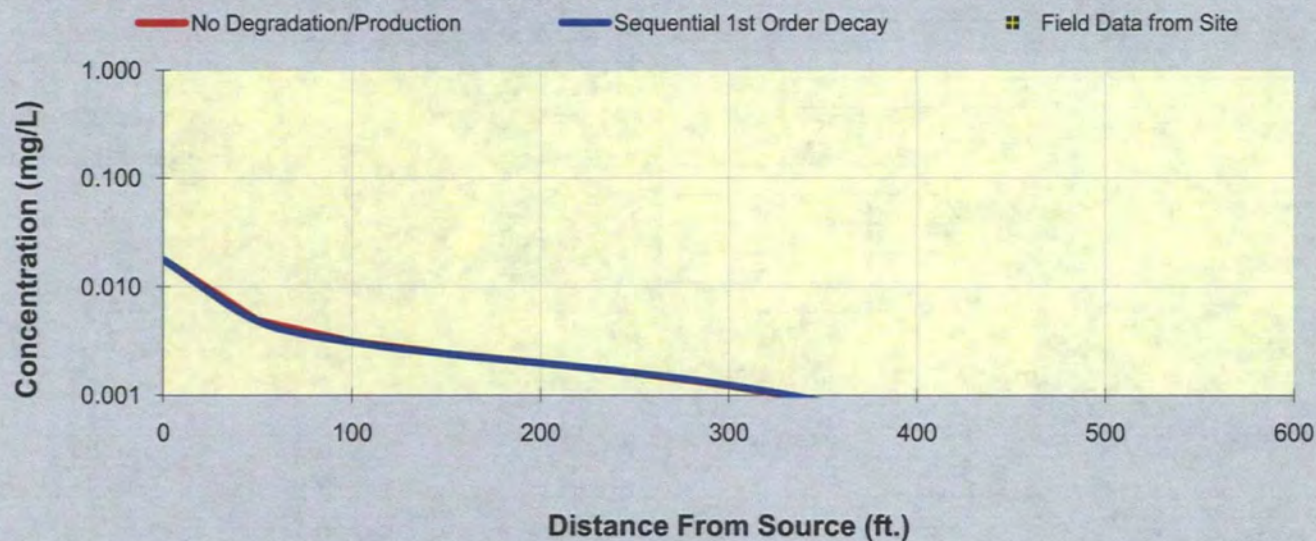


View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)											
	0	50	100	150	200	250	300	350	400	450	500	
No Degradation	0.018	0.005	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.000	0.000	
Biotransformation	0.0177	0.005	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.000	0.000	
Monitoring Well Locations (ft)												
Field Data from Site												



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

10.0 Years

Log ↔ Linear

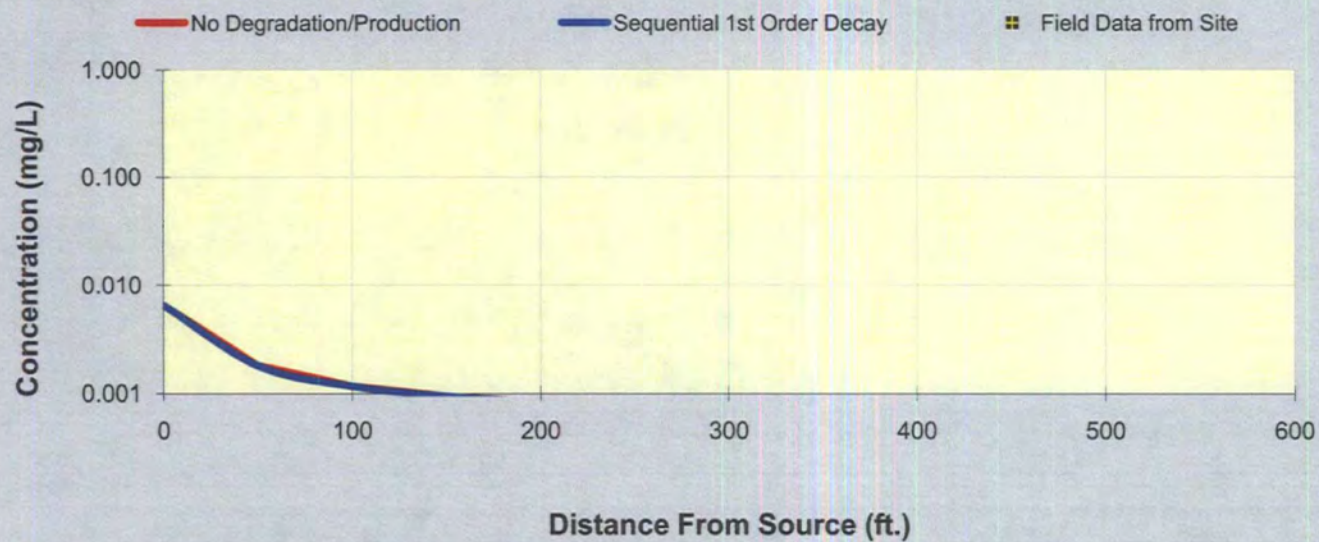
Return to
Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	50	100	150	200	250	300	350	400	450	500
No Degradation	0.006	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Biotransformation	0.0065	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

20.0 Years

Log ↔ Linear

Return to
Input

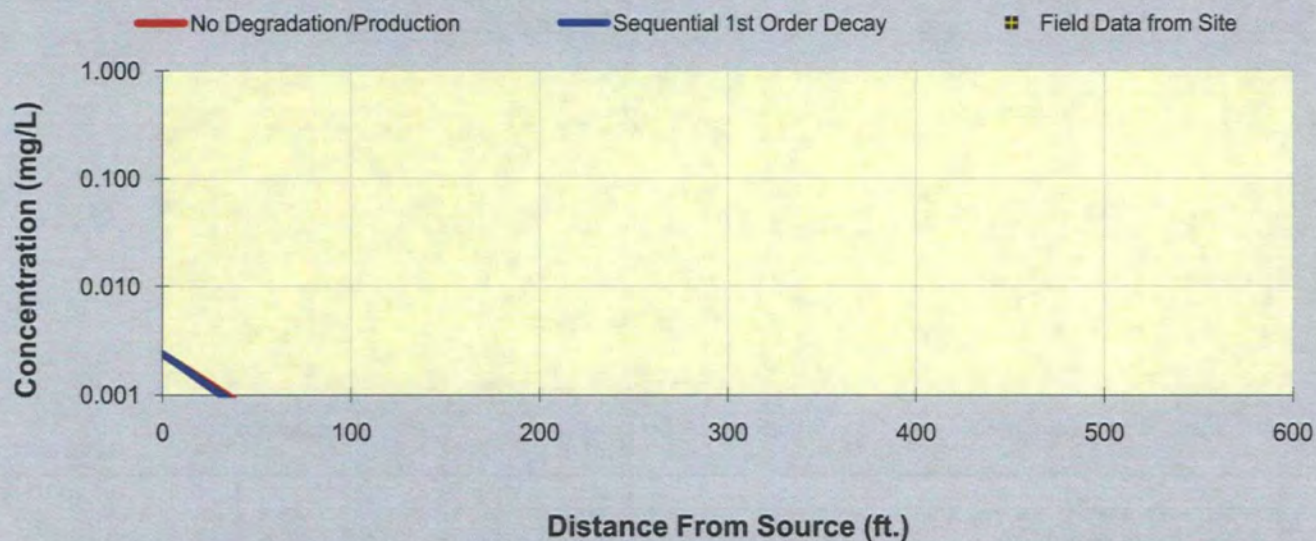
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	50	100	150	200	250	300	350	400	450	500
No Degradation	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0024	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Field Data from Site	Monitoring Well Locations (ft)											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

30.0 Years

Log \longleftrightarrow Linear

Return to
Input

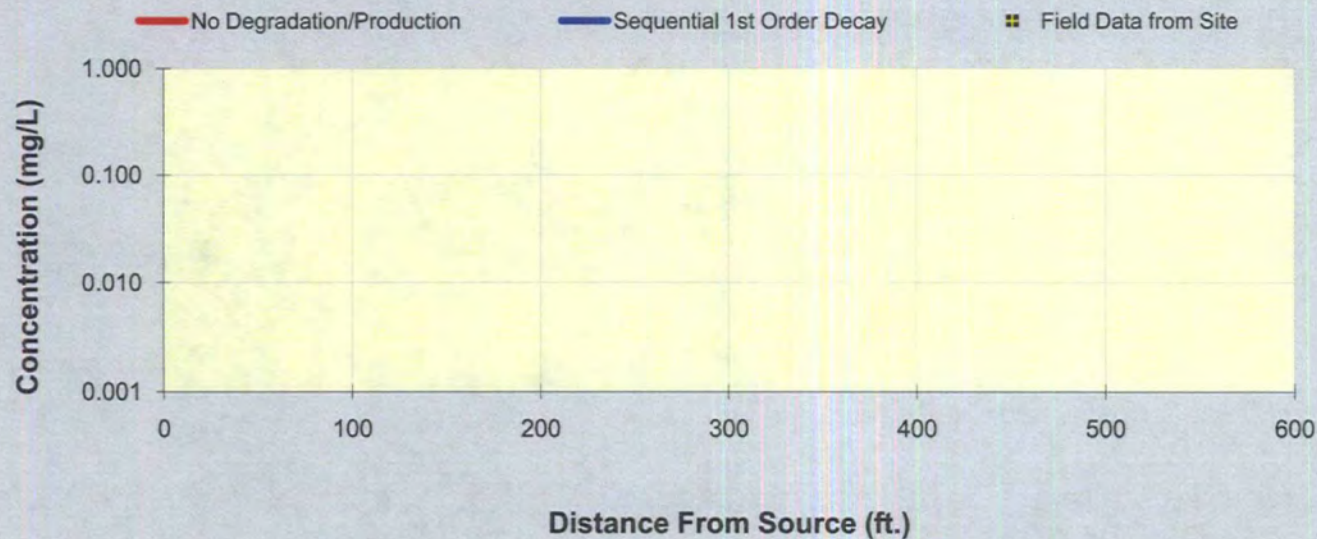
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	50	100	150	200	250	300	350	400	450	500
No Degradation	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)										
Field Data from Site										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

40.0 Years

Log \longleftrightarrow Linear

Return to
Input

To All

To Array

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Scenario 2: BIOCHLOR Monitored Natural Attenuation of PCE Plume
Hotspot 2

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BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

NJANG Egg Harbor

IRP Site 3

Run Name

TYPE OF CHLORINATED SOLVENT:

Ethenes ☒
Ethanes ☐

1. ADVECTION

Seepage Velocity* Vs 117.5 (ft/yr)
or
Hydraulic Conductivity K 4.0E-03 (cm/sec)
Hydraulic Gradient i 0.0086 (ft/ft)
Effective Porosity n 0.3 (-)

2. DISPERSION

Alpha x* 13.507 (ft)
(Alpha y) / (Alpha x)* 1.3507 (-)
(Alpha z) / (Alpha x)* 7.E-01 (-)
Calc. Alpha x

3. ADSORPTION

Retardation Factor* R
or
Soil Bulk Density, rho 1.7 (kg/L)
Fraction Organic Carbon, f_{oc} 1.0E-3 (-)
Partition Coefficient K_{oc} 426 (L/kg)
PCE 3.41 (-)
TCE (-)
DCE (-)
VC (-)
ETH (-)

Common R (used in model)* = 3.41

4. BIOTRANSFORMATION

Zone 1
PCE → TCE
TCE → DCE
DCE → VC
VC → ETH
Zone 2
PCE → TCE
TCE → DCE
DCE → VC
VC → ETH
-1st Order Decay Coefficient*
λ (1/yr) half-life (yrs) Yield
0.000 0.79
0.000 0.74
0.000 0.64
0.000 0.45
λ (1/yr) half-life (yrs)
0.000
0.000
0.000
0.000
λ HELP

5. GENERAL

Simulation Time* 100 (yr)
Modeled Area Width* 200 (ft)
Modeled Area Length* 650 (ft)
Zone 1 Length* 650 (ft)
Zone 2 Length* 0 (ft)
Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options
TYPE: Decaying Spatially-Varying
Source Thickness in Sat. Zone* 20 (ft)
Y1 Y2 Y3
Width* (ft) 25 85 131
Conc. (mg/L)* C1 C2 C3 k_s* (1/yr)
PCE .059 0.035 0.020 0.1
TCE 0.1
DCE 0.1
VC 0.1
ETH 0.1

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)
TCE Conc. (mg/L)
DCE Conc. (mg/L)
VC Conc. (mg/L)
ETH Conc. (mg/L)
Distance from Source (ft)
Date Data Collected 2006

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

Restore Formulas

RESET

SEE OUTPUT

Paste Example

Data Input Instructions:

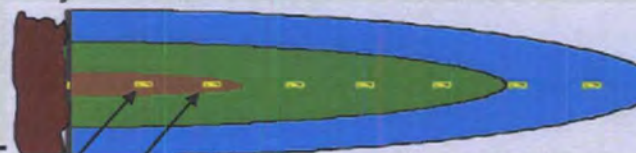
115 → 1. Enter value directly....or
↑ or 0.02 → 2. Calculate by filling in gray cells. Press Enter, then **C**
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if

Biotransformation is Occurring →

Natural Attenuation Screening Protocol

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

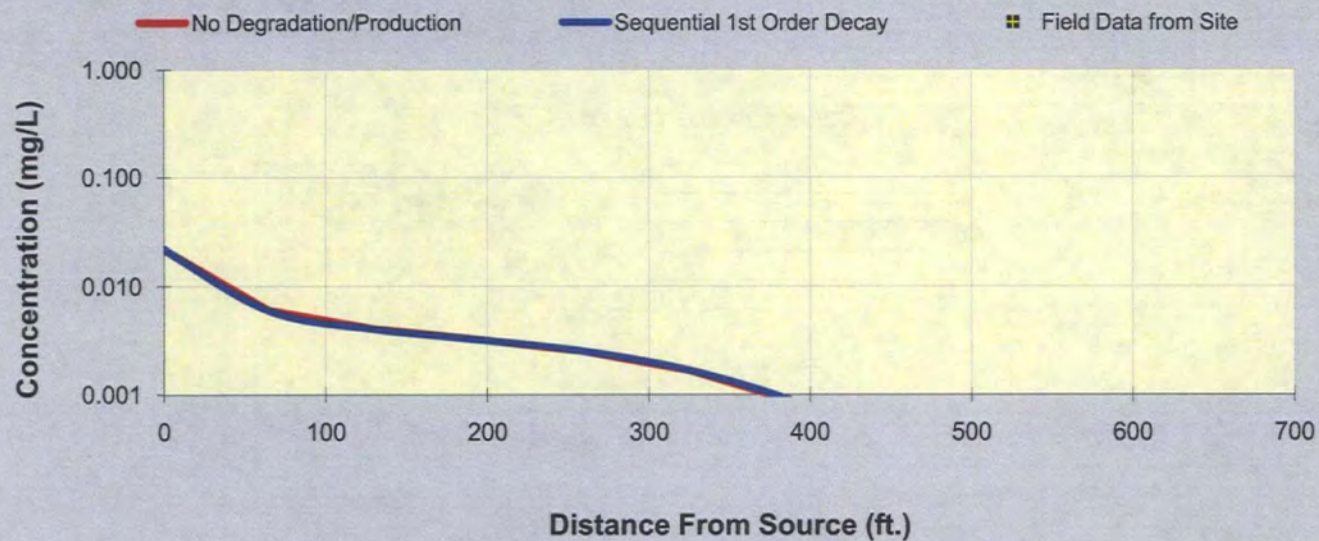


View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.022	0.006	0.004	0.003	0.003	0.002	0.001	0.000	0.000	0.000	0.000
Biotransformation	0.0217	0.006	0.004	0.003	0.003	0.002	0.001	0.000	0.000	0.000	0.000
Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

10.0 Years

Log \longleftrightarrow Linear

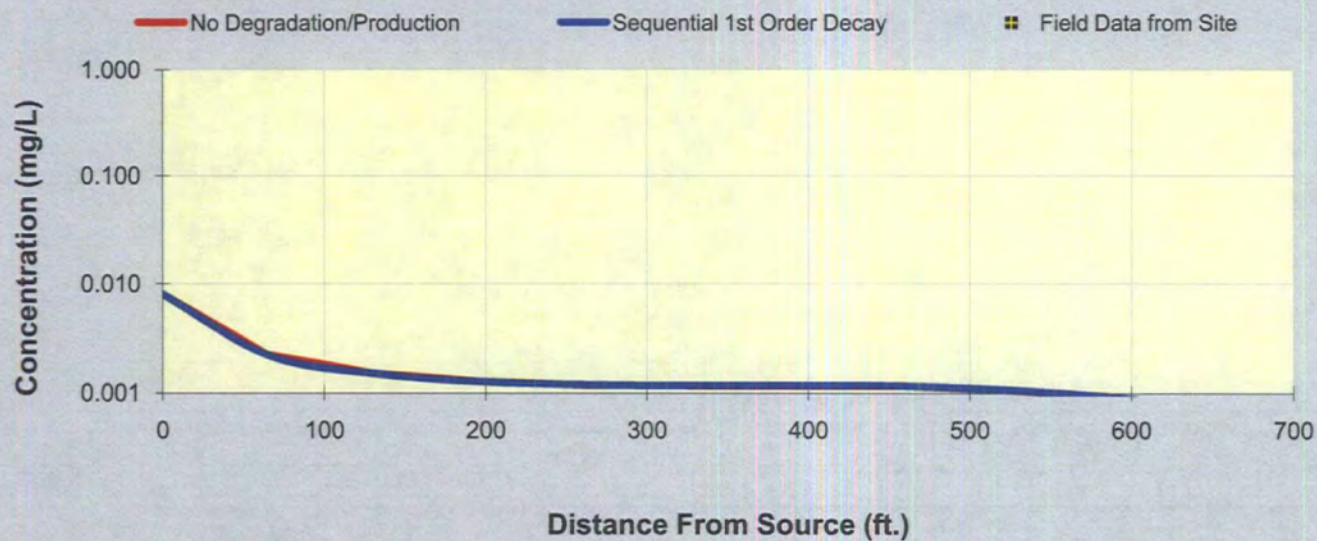
Return to
Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.008	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Biotransformation	0.0080	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

20.0 Years

Log ↔ Linear

Return to
Input

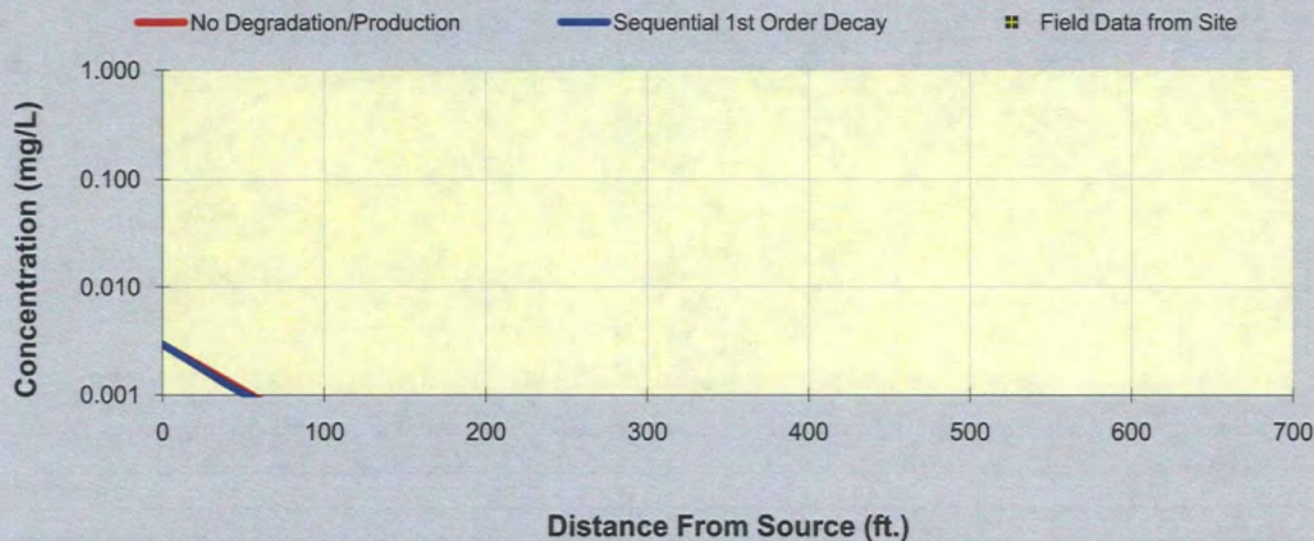
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Biotransformation	0.0029	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001

Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

30.0 Years

Log \longleftrightarrow Linear

Return to
Input

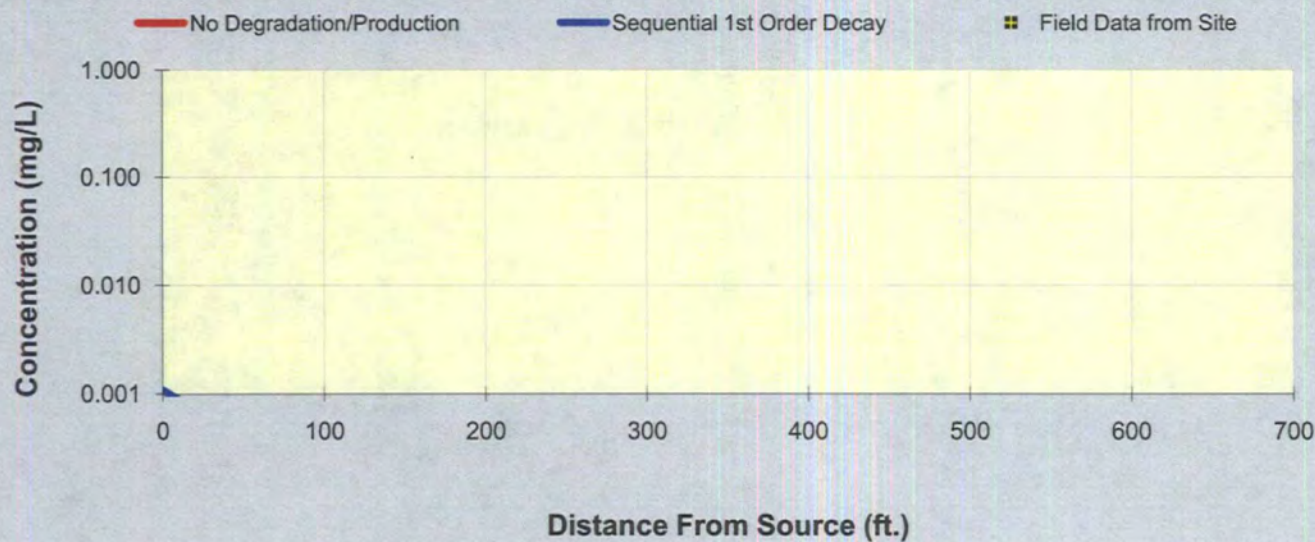
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)										
Field Data from Site										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

40.0 Years

Log ↔ Linear

Return to
Input

To All

To Array

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Scenario 3: BIOCHLOR Remediation of PCE Plume to 20 µg/l PCE

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BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

NJANG Egg Harbor

IRP Site 3

Run Name

TYPE OF CHLORINATED SOLVENT:

Ethenes ☒
Ethanes ☐

1. ADVECTION

Seepage Velocity* Vs 117.5 (ft/yr)

or

Hydraulic Conductivity K 4.0E-03 (cm/sec)
Hydraulic Gradient i 0.0086 (ft/ft)
Effective Porosity n 0.3 (-)

2. DISPERSION

Alpha x* 13.507 (ft)
(Alpha y) / (Alpha x)* 1.3507 (-)
(Alpha z) / (Alpha x)* 7.E-01 (-)
Calc. Alpha x

3. ADSORPTION

Retardation Factor* R

or

Soil Bulk Density, rho 1.7 (kg/L)
Fraction Organic Carbon, f_{oc} 1.0E-3 (-)
Partition Coefficient K_{oc} 426 (L/kg)
PCE 3.41 (-)
TCE (-)
DCE (-)
VC (-)
ETH (-)

Common R (used in model)* = 3.41

4. BIOTRANSFORMATION

Zone 1
PCE → TCE 0.000 (-) half-life (yrs) 0.79 Yield 0.79
TCE → DCE 0.000 (-) 0.74
DCE → VC 0.000 (-) 0.64
VC → ETH 0.000 (-) 0.45
Zone 2
PCE → TCE 0.000 (-) half-life (yrs) 0.79 Yield 0.79
TCE → DCE 0.000 (-) 0.74
DCE → VC 0.000 (-) 0.64
VC → ETH 0.000 (-) 0.45

5. GENERAL

Simulation Time* 100 (yr)
Modeled Area Width* 200 (ft)
Modeled Area Length* 650 (ft)
Zone 1 Length* 650 (ft)
Zone 2 Length* 0 (ft)
Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) Y1 100

Conc. (mg/L)* C1
PCE .02
TCE .0
DCE .0
VC .0
ETH 0

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)
TCE Conc. (mg/L)
DCE Conc. (mg/L)
VC Conc. (mg/L)
ETH Conc. (mg/L)
Distance from Source (ft)
Date Data Collected 2006

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

Restore Formulas

RESET

SEE OUTPUT

Paste Example

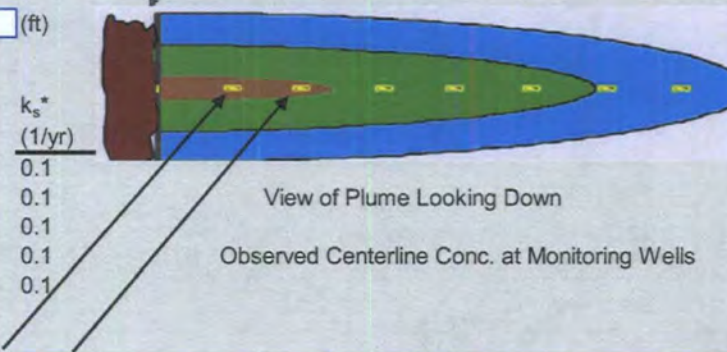
Data Input Instructions:

115 → 1. Enter value directly....or
or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then **C**
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring

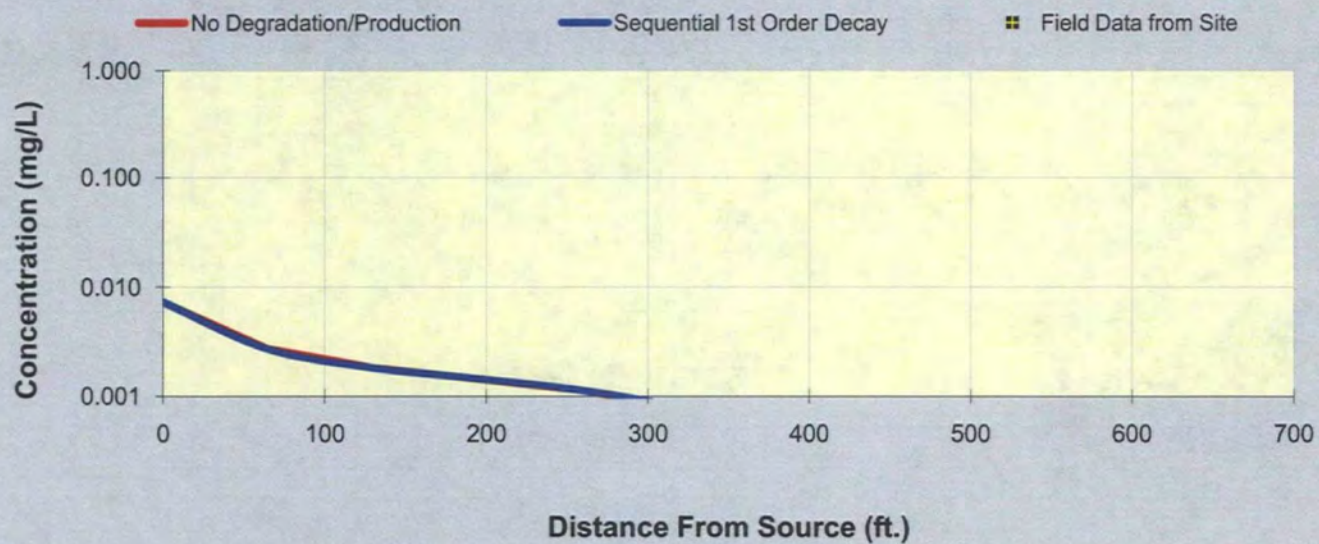
Natural Attenuation Screening Protocol

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.007	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0074	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Return to
Input

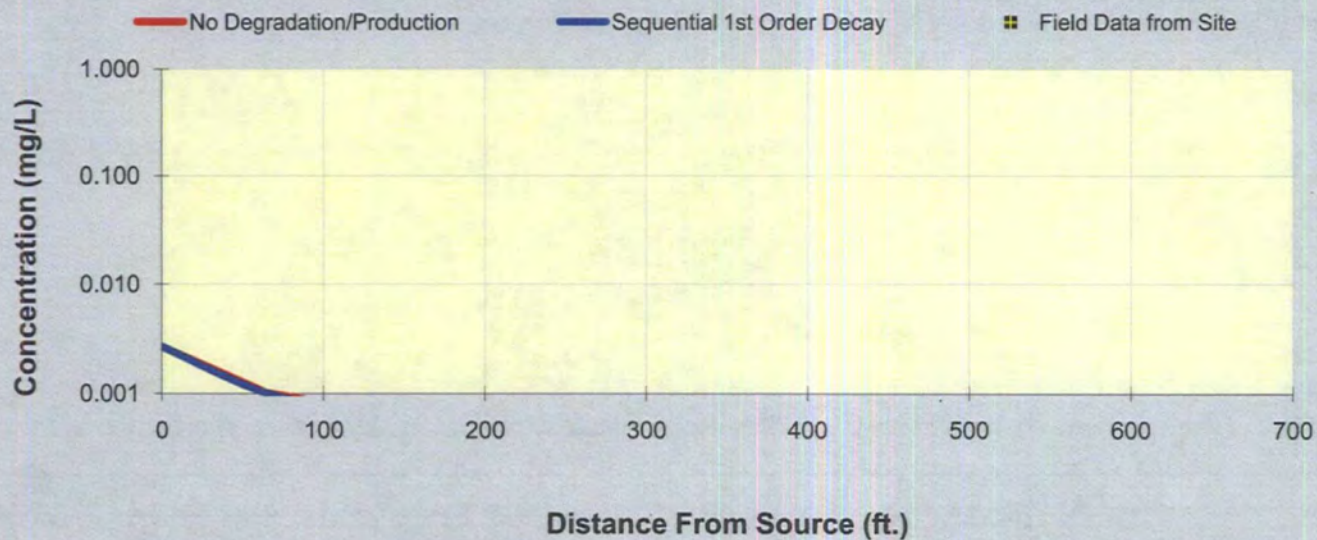
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000
Biotransformation	0.0027	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000

Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

20.0 Years

Log ↔ Linear

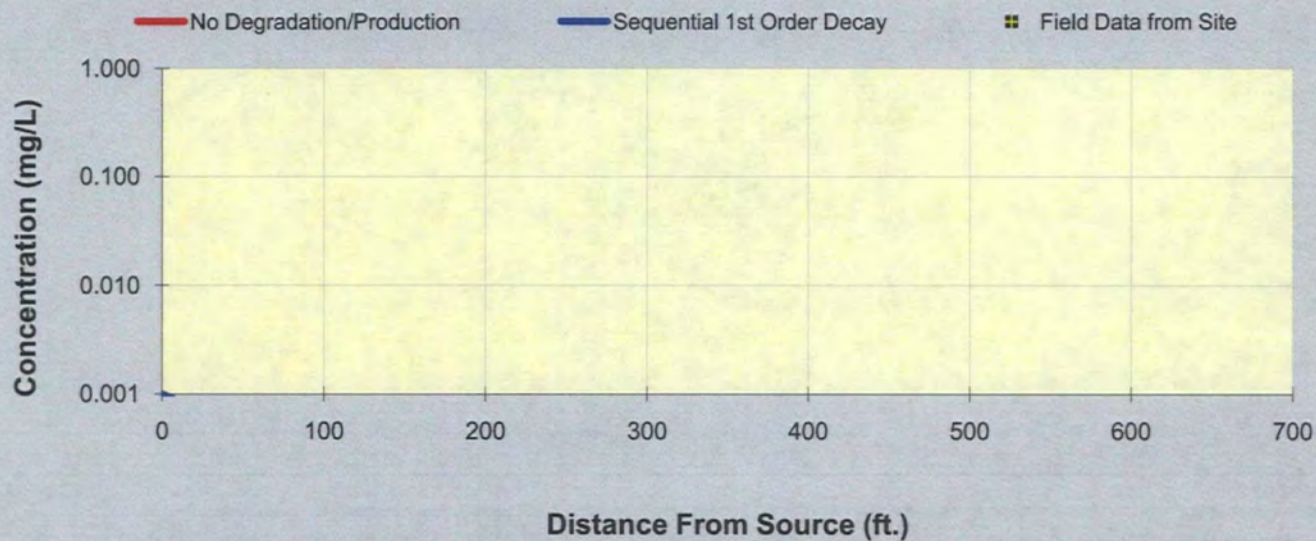
Return to
Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

30.0 Years

Log \longleftrightarrow Linear

Return to
Input

To All

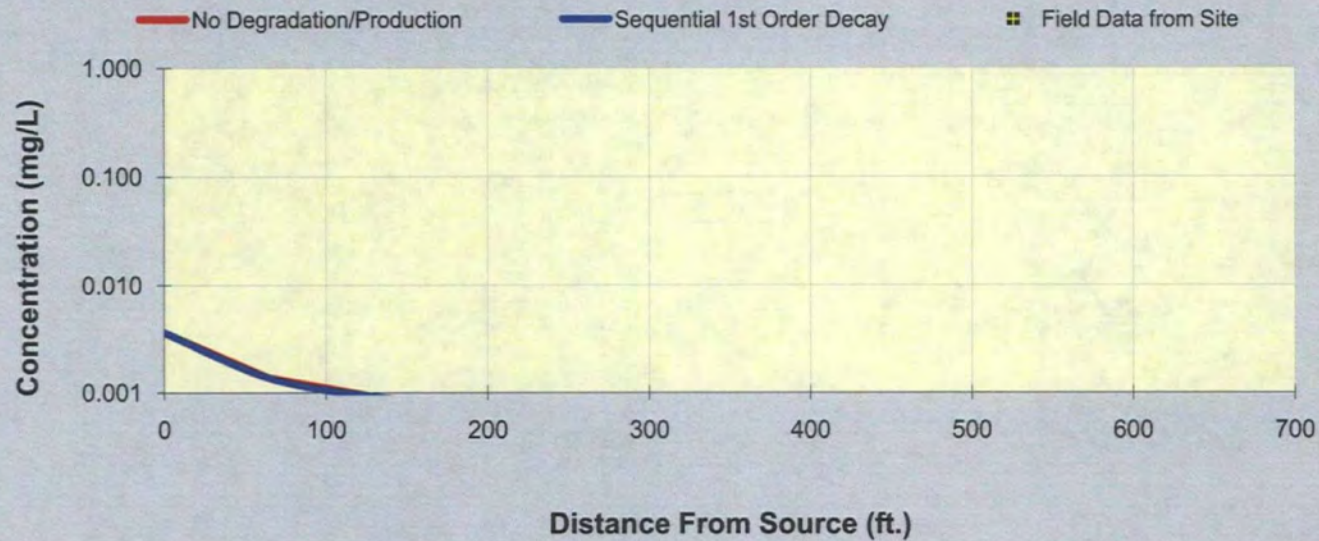
To Array

Scenario 4: BIOCHLOR Remediation of PCE Plume to 10 µg/l PCE

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DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
	No Degradation	0.004	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0037	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

10.0 Years

Log ↔ Linear

Return to
Input

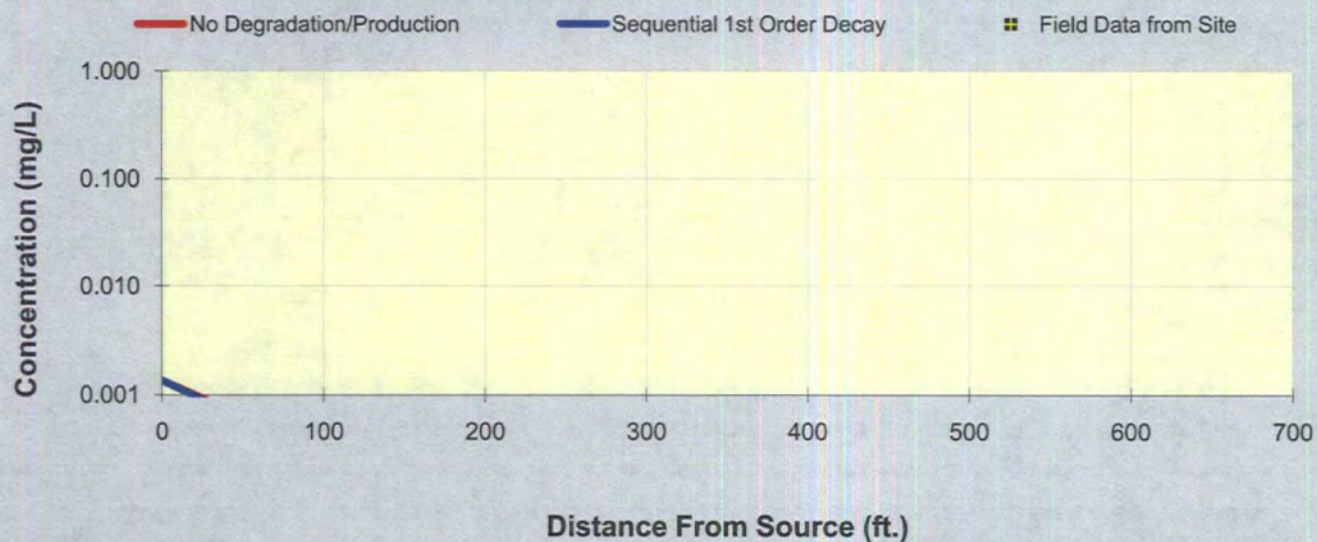
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0014	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)											
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

20.0 Years

Log ↔ Linear

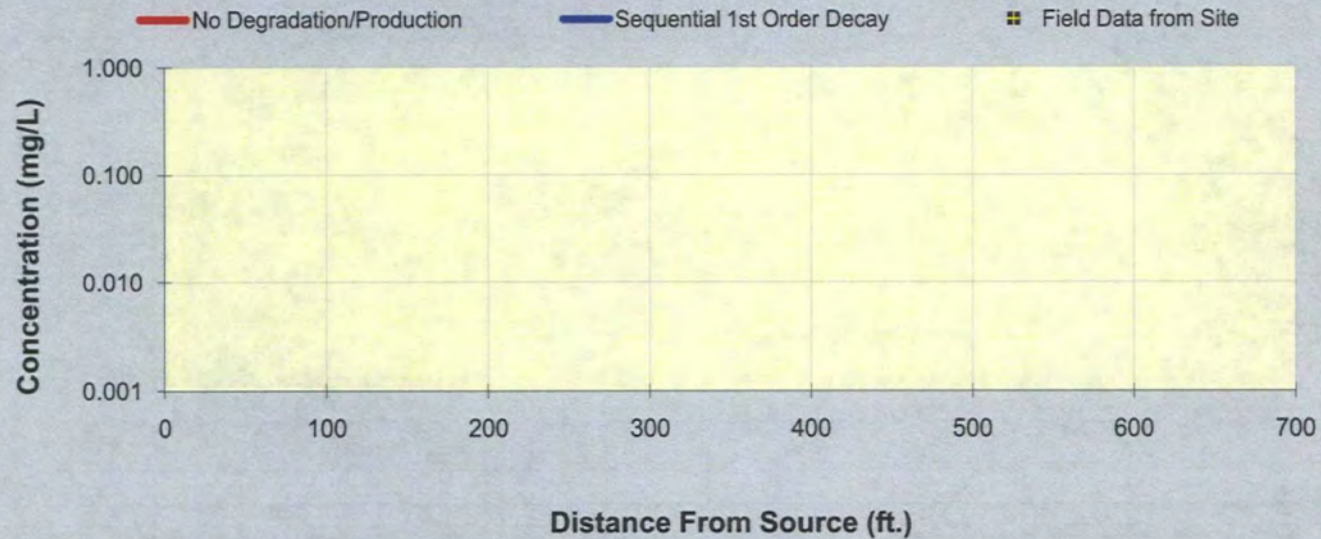
Return to
Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	65	130	195	260	325	390	455	520	585	650
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



Replay

Time:

30.0 Years

Log \longleftrightarrow Linear

Return to
Input

To All

To Array

APPENDIX D
Detailed Cost Estimates

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Cost Estimate for IRP Site 3
Alternative 2: Air Sparging/Soil Vapor Extraction

Description		Estimated Quantity	Unit	Unit Cost	Estimated Cost	Net Present Value (7% discount)	Comments/ Assumptions
Item No.	Capital Costs						
1	Monitoring Well Installation	5	Ea	\$ 2,500	\$ 12,500	\$ 12,500	
2	Monitoring Well Installation Oversight	5	Day	\$ 1,350	\$ 6,750	\$ 6,750	Assume 1 geologist for 2 days for well installation, 2 days for development and sampling, includes per diem.
	Subtotal				\$ 19,250	\$ 19,250	
	System Design and Management						
3	Engineering, Permitting, and Design	15%	of	\$ 19,250	\$ 2,888	\$ 2,888	15% of capital costs, includes \$750 for Remedial Action Permit
4	Project Management	5%	of	\$ 19,250	\$ 963	\$ 963	5% of capital costs
	Subtotal				\$ 3,850	\$ 3,850	
	Operation and Maintenance Costs						
5	Performance/Groundwater Monitoring (Labor and Equipment)	50	ea	\$ 4,200	\$ 210,000	\$108,704.18	Quarterly monitoring for 2 years, annual monitoring for 38 years, quarterly monitoring in final year, assume 1 person, 2 days, includes per diem and supplies and analytical
6	Well Abandonment/Site Decommissioning	5	Ea	\$ 500	\$ 2,500	\$ 167	
	Subtotal				\$ 212,500	\$ 108,871	
	Reporting						
7	Remedial Action Work Plan (Long- Term Monitoring Plan)	1	ea	\$ 20,000	\$ 20,000	\$ 20,000	Prepared Year 1
8	Groundwater Monitoring Report	50	ea	\$ 10,000	\$ 500,000	\$190,054.10	Quarterly monitoring for 2 years, annual monitoring for 38 years, quarterly monitoring in final year
9	5-Year Review	7	ea	\$ 15,000	\$ 105,000	\$ 33,772	Prepared every 5 years during MNA phase
10	Well Abandonment/Site Closure Report	1	ea	\$ 15,000	\$ 15,000	\$ 1,002	Prepared Yr 40
11	No Further Response Action Planned Decision Document	1	ea	\$ 10,000	\$ 10,000	\$ 668	Prepared Yr 40
	Subtotal				\$ 650,000	\$ 245,496	
	Subtotal of Alternative				\$ 885,600	\$ 377,467	
12	Contingency	10%	of	\$ 885,600	\$ 88,560	\$ 37,747	10% Contingency on entire project
	Total				\$ 974,160	\$ 415,214	

Cost Estimate for IRP Site 3
Alternative 3: Air Sparging/Soil Vapor Extraction
and Monitored Natural Attenuation

	Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost	Net Present Value (7% discount)	Comments/ Assumptions
Item No.	Capital Costs						
1	Pilot Study	1	LS	\$ 50,000	\$ 50,000	\$ 50,000	
2	AS/SVE Construction Mobilization/Demobilization	1	LS	\$ 10,000	\$ 10,000	\$ 10,000	
3	Monitoring Well Installation	5	Ea	\$ 2,500	\$ 12,500	\$ 12,500	
4	Monitoring Well Installation Oversight	5	Day	\$ 1,350	\$ 6,750	\$ 6,750	Assume 1 geologist for 2 days for well installation, 2 days for development and sampling, includes per diem
5	Electrical Service Power Drop	1	LS	\$ 14,000	\$ 14,000	\$ 14,000	3 Phase power supply
6	AS/SVE Well Installation	85	Ea	\$ 2,500	\$ 212,500	\$ 212,500	
7	AS/SVE System Labor	50	Day	\$ 3,750	\$ 187,500	\$ 187,500	Assume 3 people for 5 days set up, 20 days for well installation, 20 days for system installation, 5 days cleanup and leave site, includes per diem
8	Area 1 AS compressor (70 CFM)	2	Ea	\$ 8,000	\$ 16,000	\$ 16,000	
9	Area 1 SVE blower (200 CFM)	1	Ea	\$ 2,000	\$ 2,000	\$ 2,000	
10	Area 2 AS compressor (325 CFM)	1	Ea	\$ 27,000	\$ 27,000	\$ 27,000	
11	Area 2 SVE blower (350 CFM)	1	Ea	\$ 2,500	\$ 2,500	\$ 2,500	
12	Piping and Trenching	2328	LF	\$ 50	\$ 116,400	\$ 116,400	includes pipe, saw cutting, laying pipe, backfill, re-asphalting
13	Pre-Built Buildings	2	Ea	\$ 1,500	\$ 3,000	\$ 3,000	
14	GAC Vessels	4	Ea	\$ 500	\$ 2,000	\$ 2,000	2 per system
15	Misc System appurtenances (fittings, etc.)	2	LS	\$ 10,000	\$ 20,000	\$ 20,000	
16	PLC and Instrumentation	2	Ea	\$ 12,000	\$ 24,000	\$ 24,000	one per system
17	Manifold	85	Ea	\$ 1,000	\$ 85,000	\$ 85,000	one per well
				Subtotal	\$ 791,150	\$ 791,150	
	System Design and Management						
18	Engineering, Permitting, and Design	10%	of	\$ 791,150	\$ 79,115	\$ 79,115	10% of capital costs and includes Remedial Action Permit
19	Project Management	5%	of	\$ 791,150	\$ 39,558	\$ 39,558	5% of capital costs
20	Construction Management	8%	of	\$ 791,150	\$ 63,292	\$ 63,292	
				Subtotal	\$ 181,965	\$ 181,965	
	Operation and Maintenance Costs						
21	Electricity	36	mo	\$ 1,000	\$ 36,000	\$33,696.22	\$500/mo per system for 3 yrs
22	AS/SVE O&M parts	36	mo	\$ 200	\$ 7,200	\$6,739.24	3 yrs of O&M
23	AS/SVE O&M labor	36	mo	\$ 1,400	\$ 50,400	\$47,174.71	3 site visit per month for 3 yrs
24	Performance/Groundwater Monitoring (Labor and Equipment)	46	ea	\$ 4,200	\$ 193,200	\$106,579.56	Quarterly monitoring for 3 years, annual monitoring for 30 years, Quarterly Monitoring in final year, assume 1 person, 2 days, includes per diem and supplies and analytical
25	AS/SVE System Decommissioning	1	LS	\$ 15,000	\$ 15,000	\$ 12,244	After 3 years of active system operation
26	Well Abandonment/Site Closure	85	Ea	\$ 500	\$ 42,500	\$ 4,557	
				Subtotal	\$ 344,300	\$ 210,992	
	Reporting						
27	Remedial Action Work Plan	1	ea	\$ 40,000	\$ 40,000	\$ 40,000	Prepared Year 1
28	After Action Report	1	ea	\$ 30,000	\$ 30,000	\$ 24,489	
29	Groundwater Monitoring Report	46	ea	\$ 10,000	\$ 460,000	\$380,641.30	Quarterly reporting for 3 years, annual monitoring for 30 years, Quarterly Monitoring in final year
30	5-Year Review	5	ea	\$ 15,000	\$ 75,000	\$ 21,672	Prepared every 5 years during MNA phase
31	Well Abandonment/Site Closure Report	1	ea	\$ 15,000	\$ 15,000	\$ 1,609	Prepared Yr 33
32	No Further Response Action Planned Decision Document	1	ea	\$ 10,000	\$ 10,000	\$ 1,072	Prepared Yr 33
				Subtotal	\$ 630,000	\$ 469,484	
				Subtotal of Alternative	\$ 1,947,415	\$ 1,653,590	
33	Contingency	20%	of	\$ 1,947,415	\$ 389,483	\$ 330,718	20% Contingency on entire project (due to uncertainties with trenching and utilities)
				Total	\$ 2,336,897	\$ 1,984,308	

Cost Estimate for IRP Site 3
Alternative 4: InSitu Chemical Oxidation
and Monitored Natural Attenuation

Description		Estimated Quantity	Unit	Unit Cost	Estimated Cost	Net Present Value (7% discount)	Comments/ Assumptions
Item No.	Capital Costs						
1	Pilot Study	1	LS	\$ 50,000	\$ 50,000	\$ 50,000	
2	Injection Mobilization/Demobilization	2	LS	\$ 10,000	\$ 20,000	\$ 20,000	
3	Monitoring Well Installation	5	Ea	\$ 2,500	\$ 12,500	\$ 12,500	
4	Monitoring Well Installation Oversight	5	Day	\$ 1,350	\$ 6,750	\$ 6,750	Assume 1 geologist for 2 days for well installation, 2 days for development and sampling, includes per diem
5	Injection Well Installation	90	Ea	\$ 2,500	\$ 225,000	\$ 225,000	
6	NaMnO4 Injection #1	1608	gal	\$ 30	\$ 48,240	\$ 48,240	Assumes NaMnO4 is delivered in 40% concentration.
7	Injection #1 Equipment	1	LS	\$ 10,000	\$ 10,000	\$ 10,000	
8	20,000-gallon frac tank	2	Ea	\$ 1,200	\$ 2,400	\$ 2,400	
9	Injection #1 Labor	50	Day	\$ 3,750	\$ 187,500	\$ 187,500	Assume 3 people for 5 days set up, 22 days for well installation, 18 days for injection, 5 days cleanup and demob, includes per diem
10	NaMnO4 Injection #2	804	gal	\$ 30	\$ 24,120	\$ 24,120	Assume 1/2 LOE as Injection #1
11	Injection #2 Equipment	1	LS	\$ 5,000	\$ 5,000	\$ 5,000	Assume 50% supplies reusable from injection #1
12	Injection #2 Labor	25	Day	\$ 3,750	\$ 93,750	\$ 93,750	Assume 1/2 LOE as Injection #1
	Subtotal				\$ 685,260	\$ 685,260	
	Remedial Design and Management						
13	Engineering, Permitting, and Design	10%	of	\$ 685,260	\$ 68,526	\$ 68,526	10% of capital costs and includes Remedial Action Permit
14	Project Management	5%	of	\$ 685,260	\$ 34,263	\$ 34,263	5% of capital costs
	Subtotal				\$ 102,789	\$ 102,789	
	Operation and Maintenance Costs						
15	Performance/Groundwater Monitoring (Labor and Equipment)	42	Yr	\$ 3,800	\$ 159,600	\$70,298.28	Quarterly GW monitoring for 2 years during treatment, then annual monitoring for 30 years, Quarterly Monitoring in final year, assume 40 hr LOE for 1 person
16	Well Abandonment/Site Decommissioning	85	Ea	\$ 500	\$ 42,500	\$ 39,720	
	Subtotal				\$ 159,600	\$ 70,298	
	Reporting						
17	Remedial Action Work Plan	1	ea	\$ 40,000	\$ 40,000	\$ 40,000	Prepared Year 1
18	After Action Report	1	ea	\$ 30,000	\$ 30,000	\$ 28,037	
19	Groundwater Monitoring Report	42	ea	\$ 10,000	\$ 420,000	\$277,493.23	Quarterly GW report for 1 year during treatment, then annual monitoring for 30 years, Quarterly Monitoring in final year
20	5-Year Review	5	ea	\$ 15,000	\$ 75,000	\$ 28,408	Prepared every 5 years during MNA phase
21	Well Abandonment/Site Closure Report	1	ea	\$ 15,000	\$ 15,000	\$ 1,842	Prepared Year 31
22	No Further Response Action Planned Decision Document	1	ea	\$ 10,000	\$ 10,000	\$ 1,228	Prepared Year 31
	Subtotal				\$ 590,000	\$ 377,008	
	Subtotal of Alternative				\$ 1,537,649	\$ 1,235,355	
23	Contingency	10%	of	\$ 1,537,649	\$ 153,765	\$ 123,536	10% Contingency on entire project - fewer uncertainties than with other alternatives
	Total				\$ 1,691,414	\$ 1,358,891	

Cost Estimate for IRP Site 6
Alternative 2: Excavation and Disposal

Description		Estimated Quantity	Unit	Unit Cost	Estimated Cost	Net Present Value (7% discount)	Comments/ Assumptions
Item No.	Capital Costs						
1	Mobilization/Demobilization	1	LS	\$ 2,500	\$ 2,500	\$ 2,500	
2	Clearing/grubbing site	0.5	day	\$ 1,500	\$ 750	\$ 750	
3	Erosion Control Installation	1	LS	\$ 500	\$ 500	\$ 500	
4	Excavation of Impacted Soil	30	CY	\$ 50	\$ 1,500	\$ 1,500	Includes equipment and operator
5	Waste Characterization and Analytical Sampling	8	ea	\$ 100	\$ 800	\$ 800	
6	Non Hazardous Soil Transportation	40.5	ton	\$ 30	\$ 1,215	\$ 1,215	
7	Non Hazardous Soil Disposal	40.5	ton	\$ 45	\$ 1,823	\$ 1,823	
8	Backfill material	40.5	ton	\$ 55	\$ 2,228	\$ 2,228	
9	Backfilling excavation	30	CY	\$ 50	\$ 1,500	\$ 1,500	
10	Re-seeding	1	LS	\$ 1,000	\$ 1,000	\$ 1,000	
				Subtotal	\$ 13,815	\$ 13,815	
	Remedial Design and Management						
11	Engineering, Permitting, and Design	5%	of	\$ 13,815	\$ 691	\$ 691	5% of capital costs
12	Project Management	5%	of	\$ 13,815	\$ 691	\$ 691	5% of capital costs
13	Construction Management	8%	of	\$ 13,815	\$ 1,105	\$ 1,105	8% of capital costs
				Subtotal	\$ 2,487	\$ 2,487	
	Reporting						
14	Remedial Action Work Plan	1	ea	\$ 15,000	\$ 15,000	\$ 15,000	Prepared Year 1
15	After Action Report	1	ea	\$ 15,000	\$ 15,000	\$ 15,000	Prepared Year 1
16	No Further Response Action Planned Decision Document	1	ea	\$ 10,000	\$ 10,000	\$ 10,000	Prepared Year 1
				Subtotal	\$ 40,000	\$ 40,000	
				Subtotal of Alternative	\$ 56,302	\$ 56,302	
17	Contingency	10%	of	\$ 56,302	\$ 5,630	\$ 5,630	10% Contingency on entire project
				Total	\$ 61,932	\$ 61,932	